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Elementary Teachers' Perceptions of Teaching Mathematics, Mathematics Anxiety, and Teaching Mathematics Efficacy

Brittany Elaine Porter
bragg52@live.marshall.edu

ELEMENTARY TEACHERS' PERCEPTIONS OF TEACHING MATHEMATICS, MATHEMATICS ANXIETY, AND TEACHING MATHEMATICS EFFICACY

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Brittany Elaine Porter
Approved by
Dr. Elizabeth Campbell, Committee Chairperson
Dr. Edna Meisel
Dr. Tina Allen
Dr. Carla Warren

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APPROVAL OF DISSERTATION

We, the faculty supervising the work of **Brittany Elaine Porter**, affirm that the dissertation, ELEMENTARY TEACHERS' PERCEPTIONS OF TEACHING MATHEMATICS, MATHEMATICS ANXIETY, AND TEACHING MATHEMATICS EFFICACY meets the high academic standards for original scholarship and creative work established by the EdD Program in **Curriculum and Instruction** and the College of Education and Professional Development. This work also conforms to the editorial standards of our discipline and the Graduate College of Marshall University. With our signatures, we approve the manuscript for publication.

Campbell, Elizabeth Ann Digitally signed by Campbell, Elizabeth Ann Date: 2019.07.01 12:15:51 -04'00'	Dr. Elizabeth Campbell	7-1-19
Curriculum and Instruction	Committee Chairperson Major	Date
Edna M. Meisel Digitally signed by Edna M. Meisel Date: 2019.08.06 11:05:04 -04'00'	Dr. Edna Meisel	8-6-19
Curriculum and Instruction	Committee Member Major	Date
Tina Allen Digitally signed by Tina Allen Date: 2019.08.06 11:26:54 -04'00'	Dr. Tina Allen	8/6/19
Curriculum and Instruction	Committee Member Major	Date
Carla Warren Digitally signed by Carla Warren Date: 2019.07.02 08:04:29 -04'00'	Dr. Carla Warren	7-2-19
	Committee Member External	Date

DEDICATION PAGE

This work is dedicated to: my husband, Shawn; my children: Ashton, Christian, Kamden, and Avionna; and my extended family. If it was not for the support of my amazing husband and children, I would have never been able to accomplish my dreams. Thank you all for your continuous support.

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ABSTRACT

Predicated on the understanding that teachers who are more comfortable with mathematics will better teach it, this study aimed to explore the extent to which building participating teachers' mathematics efficacy might also help teachers build metacognitive awareness with regards to effectively teaching mathematics, decreasing their mathematics anxiety and ameliorating negative perceptions about teaching elementary mathematics. To analyze teachers' perceptions with regards to math, teaching mathematics, and their own content knowledge, qualitative research methods were utilized. The participants began the study with an open-ended survey gauging their attitudes, confidence, and anxiety about math. The participants were observed during their trainings and their classroom lessons. Teachers' math anxiety was observed and discussed. The participants were interviewed at the end of the mentoring and coaching professional development program. This research suggested there is a relationship, though not significant, between the negative perceptions and math anxiety participants felt and what and how they taught. When teachers participated in the tailored mentoring and coaching program their overall confidence levels in math content and teaching mathematics efficacy improved.

CHAPTER 1: INTRODUCTION

Introducing the Problem

In 2017, the Nation's Report Card, a publication of the National Assessment of Educational Progress (NAEP), reported that only 35% of West Virginia's fourth graders scored at or above the proficient level in mathematics, compared to 40% of the nation's fourth graders who scored at or above the proficient level (West Virginia Overview Grade 4 Mathematics, 2017). An examination of possible reasons for the lower than national average scores suggests that a variety of factors may account for the low performance of West Virginia's fourth graders. One influential factor may lie in the perceptions of West Virginia elementary school teachers who express discomfort with teaching math content. While requirements for pre-service educators include mathematics as preparation for teaching a multi-subject curriculum, the course requirements are different for each content area. For example, in many cases, elementary educators can graduate from college having completed only one college level math course. It stands to reason that perhaps additional coursework in mathematics could lessen elementary teachers' struggles with teaching mathematics and improve their overall confidence in teaching math.

Among other factors to consider when examining students' lower than average performance in mathematics is the influence of teacher anxiety. Peker and Erterkin (2011) found a link between teachers' experiencing mathematics anxiety and feeling anxious about teaching mathematics. Taking their findings one step further, they suggested that teachers who were afraid of doing mathematics experienced greater fear for teaching mathematics. Consequently, a fear of teaching mathematics could lead to avoiding mathematics instruction. Maloney and Beilock (2012) completed research that suggested math anxious teachers and teachers who are less comfortable with mathematics could allow those weaknesses to affect their planning and the

amount of mathematics content that they include in their curriculum. A study by Sloan (2010) agreed with their findings. Sloan found that higher levels of math anxiety and lower levels of mathematical ability resulted in less engagement with mathematics in the classroom. He concluded that teachers who do not feel comfortable with mathematics may be less likely to incorporate math into their daily plan. Research has concluded that this has been going on for quite a while in our education system (Sloan, 2010; Swetman, Munday, & Windham, 1993). Swetman, et al. (1993) concluded in their research that teachers tend to teach well what they like and not teach well what they do not like.

The lack of teacher confidence and mathematics content expertise, along with possible levels of math anxiety, may contribute to negative perceptions and attitudes related to teaching mathematics. Consequently, negative perceptions and attitudes associated with mathematics teaching may be one explanation for regular underachievement by students on standardized math achievement tests. As a way of exploring solutions and addressing the challenges of increasing overall mathematics teaching efficacy of the nation's elementary school teachers, this study explored the effects of a professional development program in addressing elementary school teachers' discomfort with teaching mathematics. The program provided mentoring and coaching as well as professional development that was personally and contextually tailored to meet the needs of each participant. The main goal was to help increase elementary teachers' overall mathematics teaching efficacy. The action research upon which this study was based was designed to improve teacher meta cognitive awareness with regards to effectively teaching mathematics, while also decreasing their mathematics anxiety and removing negative perceptions about teaching elementary-level mathematics. The key concepts in this study were: 1) developing teachers' abilities in elementary mathematics; 2) increasing their confidence in

teaching elementary mathematics; and 3) reducing their math anxiety and overall negative perceptions related to teaching elementary mathematics.

Statement of the Problem

In West Virginia, prospective elementary educators must meet the minimum requirement of obtaining a bachelor's degree in Elementary Education, K-6, which qualifies them to teach all subjects in grades K-6, including math. Review of the minimum course requirements for a bachelor's degree in elementary education at two major West Virginia universities shows that both universities require students to take fewer math content courses than three other core subjects (English, Social Studies, and Science). Both universities require completion of only one college math course to earn a degree in elementary education, and students can choose the math content subject and difficulty level they prefer, ranging from college algebra to statistics (Elementary Education K-6 Comprehensive, 2017). One of these universities also requires its graduates with an elementary education degree to have successfully completed three math methods courses. However, at both universities, the same degree places much higher requirements on graduates to successfully complete courses in language arts, science and social studies.

To better understand how teacher preparation programs should support the teaching of math, it is helpful to consult the West Virginia College and Career Readiness Standards which, for sixth grade, include teaching algebraic concepts (Mathematics-Grade 6, n.d.). A single math content and three teaching mathematics methods courses (currently required for some prospective elementary educators to take in order to graduate with an elementary education degree) will likely not be enough to adequately prepare future elementary educators to teach mathematics up through the algebraic concepts required in grade six, especially if the future teacher selects a topic other than algebra for her single math content class. According to Hill,

Rowan, & Ball (2005), teachers who do not have an in-depth understanding of algebra will not be prepared to teach their students through different methods, nor to be masters of a subject that the teachers themselves have not mastered.

Content Expertise

Expectations for content expertise have grown along with increased difficulty in math standards. For example, West Virginia College and Career Readiness Standards for fourth and fifth grade mathematics include algebraic thinking, number and operations in fractions, and geometry (Mathematics- Grade 5, n.d.). These standards are more difficult than what they were ten to twenty years ago for the same grade levels (Hamilton, et al., 2007). Still, according to Boyd, et al., (2012), many of today's educators can graduate with a teaching degree after taking only one college-level advanced math content course, by which is meant algebra, trigonometry, and so on. One major West Virginia university, for example, only requires one college level mathematics course to be taken for the degree in elementary education, and teacher candidates are free to select the difficulty level of the course taken (Elementary Education K-6 Comprehensive, 2017). In addition, that same university also requires elementary education degree graduates to successfully complete three mathematics methods courses in which students learn how to teach math. However, the same degree requires its teacher candidates to successfully complete two courses in English and three in literature and language arts methods, one in science and four in science methods, and one in social studies and four in social studies methods. If prospective elementary educators are not gaining the same levels of subject knowledge and pedagogical expertise in mathematics as they are in English and reading, for example, it stands to reason that they will not be as well prepared to teach mathematics as they are able to teach English and reading.

The four math-related courses—again, one content course and three teaching methods courses—these prospective elementary educators take to obtain their teaching degrees are not enough to adequately prepare them to teach mathematics up to sixth grade, according to Hill, et al. (2005). To effectively teach mathematics, teachers must possess a deep understanding of their mathematics content so they can answer student questions, teach the concept in multiple ways to better reach all students, make connections to previously learned concepts, and provide real world examples that can translate the abstract concepts that are being taught into tangible ideas for students. Hill, et al. (2005) explained the depth of mathematical knowledge teachers need to teach mathematics to students:

> Teachers of mathematics not only need to calculate correctly but also need to know how to use pictures or diagrams to represent mathematics concepts and procedures to students, provide students with explanations for common rules and mathematical procedures, and analyze students' solutions and explanations. (p. 372)

Hill, et al. (2005) go on to conclude that teachers who are highly proficient in mathematics will help others learn mathematics only if they are able to put that knowledge to work in their teaching: to understand where students are missing a key component, to ascertain and select good assignments, to manage discussions of important ideas, as well as relevant and useful work on skills.

The West Virginia College and Career Readiness Standards for sixth grade include algebraic concepts, but teachers are presumed competent to teach advanced mathematics after completing only one college level math content course. If teachers do not gain in-depth understandings of algebra from that one college level content class, it seems unreasonable to expect they will be able to teach their students, through different methods, to reach mastery of a subject they themselves do not know.

Mathematics Anxiety

Teachers' lack of mathematics content knowledge is aggravated by the relatively common experience of "math anxiety" among non-math teachers. Vahedi and Farrokhi (2011) define math anxiety as negative cognitions, avoidance behaviors, and feelings of being pressured and/or inadequate in their mathematics ability; combined, these symptoms severely interfere with solving math related problems, both in real life and academic situations. Johnson and VanderSandt (2011) investigated mathematics anxiety among education majors who were enrolled in special education, deaf and hard of hearing, early childhood, and elementary education. They found that elementary teacher candidates were concerned about their math anxiety and worried about how it might affect their future students. In the researchers' investigation into how early math anxiety may begin, Johnson and VanderSandt (2011) linked mathematics anxiety to prior formal instruction experienced as early as elementary school. Although there is significant research on mathematics anxiety felt by elementary teacher candidates, studies have produced little information on mathematics anxiety among current elementary teachers to include the extent to which that anxiety might affect students' mathematics achievement (Johnson & VanderSandt, 2011; Bates, Latham, & Kim, 2013; Latterell & Wilson, 2016).

Mathematic Standards, Needed Levels of Expertise

Elementary educators are underprepared to teach some of the math standards they are presumed qualified to teach. Wiersma and Weinstein (2001) found research to substantiate the claim that most elementary teacher candidates and elementary teachers are at a relatively low level of mathematical sophistication. Many teachers have strong negative perceptions with regards to mathematics and teaching mathematics. In the study, teacher personal concepts are defined as how teachers view, act, and process elementary math, and their confidence in their

ability to teach elementary math. Research conducted by Patton, Fry, and Klages (2008) pointed out some telling negative perceptions held by elementary teachers in their study, quoting one teacher as saying "I really don't like math but I can teach it to elementary students without any problem" (p.488) and another as saying, "It's just elementary school math, it's not like I'm teaching anything really difficult. Otherwise, no way I would do it" (p. 489). These statements lend insight into some of the challenges posed by teacher beliefs regarding their teaching of elementary-level mathematics, and thus some of the challenges of effective elementary mathematics instruction (Patton, et al., 2008). In summary, to effectively teach elementary mathematics, teachers must change their misconceptions about mathematics teaching and develop their metacognitive awareness.

Rationale of the Study

Research suggests that mathematical skills are critical for effectively navigating life's experiences. Phillips (2007) points out that many Americans struggle with basic math-related skills. Therefore, not only do we need to increase students' math achievement, we need to increase basic math skills across the population. According to Andrews and Brown (2014), 58% of American adults cannot calculate a tip, 71% cannot calculate miles per gallon, and 78% of American adults cannot calculate the interest on a loan. Murnane and Levy (1996) reported that half of America's seventeen-year olds could not perform the math needed to obtain a job at a modern day automobile plant (as cited in United States Department of Education, 2008).

Clearly, there is a need for an intervention in mathematics education; from the perspective of an experienced mathematics teacher, it seems logical to focus on teaching and learning in elementary schools. An increasing amount of research has emerged in which early experiences and education have been determined to greatly impact later mathematical achievement (Boat, Warner, & O'Connell, 2009; Duncan, Ludwig, & Magnuson, 2007,

Magnuson, & Duncan, 2016; Watts, Gandhi, Ibrahim, Masucci, & Racer, 2018). Ineffective instruction, math anxiety, and negative perceptions about mathematics can all be detrimental to student achievement. In particular, math anxiety strongly affects mathematics achievement at every age level (Ashcraft, & Kirk, 2001; Hembree, 1990; Ramirez, Gunderson, Levine, & Beilock, 2013.

Recent arguments commonly lean toward the view that it is now more important than ever for students to understand mathematics, and to understand beyond a superficial level. Geist (2015) stated that the realm of mathematics is no longer restricted to a select few: "All young Americans must learn to think mathematically, and they must think mathematically to learn" (p. 1). Ball, Hill, & Bass (2002) concluded that students' learning is dependent on more than one factor: teachers' content knowledge, their ability to interact with students with their own student content knowledge, and students' own thinking about the mathematical content. Educators believe that elementary teachers need opportunities to develop deep understandings of the mathematics content for which they will be held accountable to teach (Conference Board of the Mathematical Sciences, 2001; National Council of Teachers of Mathematics, 2000). If the development of deep understandings of mathematics content does not happen while they are obtaining their teaching degrees, school districts need to be willing and able to fill in the gap in elementary teachers' depth of mathematics understanding. Math anxiety must also be addressed, as the overwhelming amount of research substantiating math anxiety's negative effects on students' math ability, current achievement, and future math achievement demonstrates. Ma's (1999) meta-analysis on 26 studies dealing with the relationship between anxiety and achievement indicated a statistically negative correlation between the two and found that relationship to be consistent regardless of gender, grade level, ethnicity, or year of publication. Hembree (1990) concluded that individuals with math anxiety often avoid studies in math,

therefore limiting their career options. Not only does math anxiety affect student achievement, it affects how teachers assess their own mathematics abilities. Geist (2010) found that the more math anxiety teachers report, the lower they rate their own abilities in mathematics.

Previous studies have shown that there are several factors that contribute to elementary school educators' discomfort with teaching math; among these are levels of personal efficacy, anxiety, and confidence. Underlying reasons may relate to lack of knowledge and teaching methods in advanced math concepts. This qualitative study explored ways for these issues to be acknowledged in schools and to help participating teachers become more effective mathematics teachers by gaining greater confidence in their mathematics abilities and feel less anxious about math. Mentoring and coaching, as components of a professional development program designed to address areas of discomfort in teaching mathematics provided participants with learning how to be more effective elementary-level mathematics teachers.

Purpose of the Study

The purpose of this study was to:

- Examine the levels of confidence and anxiety felt by participating elementary school teachers related to teaching math
- Provide participants with mentoring, coaching, and resources in a professional development program designed to relieve anxiety levels associated with teaching math
- Explore current confidence levels and math anxiety levels of participating elementary school teachers
- Provide participants with resources to increase their confidence in their ability to be effective elementary math teachers
- Decrease their own math anxiety.

As noted above, elementary-level teachers' negative perceptions related to teaching mathematics may negatively affect their students' perceptions of mathematics. Studies that examined math teaching determined that teachers who are more comfortable with mathematics will be more effective in their teaching of math, have greater confidence, and experience less anxiety. Influential factors affecting comfort with teaching mathematics are knowledge of math content and teaching methods.

Hill, et al. (2005) completed research to suggest that elementary educators are not taking enough content courses in college to be adequately prepared to teach elementary mathematics. Hill et al. (2005) went on to conclude that teachers who are highly proficient in mathematics and are capable in using their own knowledge to perform the tasks they must enact as teachers will help others learn mathematics. Similarly, Wiersma and Weinstein (2001) found that most elementary teacher candidates and elementary teachers are at a low level of mathematical sophistication.

There is significant research examining math anxiety experiences by elementary teacher candidates. Findings by Bates, et al. (2013), Johnson & VanderSandt (2011), and Latterell & Wilson (2016) linked math anxiety as influential in elementary teachers' lack of mathematics knowledge.

The body of research that has resulted in findings that elementary school teachers experience math anxiety, convey negative perceptions of mathematics, possess low levels of math knowledge and teaching methods, and express low levels of confidence in their abilities to teach mathematics provides reasons that may influence teachers' attitudes to avoid or lack interest in teaching mathematics. The impact of these attitudes can be influential factors in low student scores on standardized math achievement tests. Therefore, improving teacher confidence, knowledge, and efficacy could positively affect the outcomes of student test scores.

A program of professional development featuring mentoring and coaching that provides resources in mathematics content and methods has reasonable expectations for addressing low teacher confidence, knowledge, and efficacy.

Setting

This study took place at a rural West Virginia elementary school with enrollment below 250 students in grades Pk-5. Like many rural West Virginia schools, the elementary school enrolled approximately 95% white students. More than half of these students were classified in the Low SES category, and nearly one fifth of the students were identified as special education (WV Department of Education, 2018). At the time of the study, the rural elementary school employed approximately 22 teachers and teachers' aides.

Significance of the Study

Educators' lack of mathematics content knowledge negatively impacts their ability to increase student content knowledge and also affects their overall math perspective. Johnson and VanderSandt (2011) investigated mathematics anxiety amongst education majors who were enrolled in special education, deaf and hard of hearing, early childhood, and elementary education pre-service teacher programs. They found that elementary teacher candidates were concerned about their math anxiety and its potential to affect their future students' learning of math. In their investigation into how early math anxiety may begin, they linked mathematics anxiety to prior formal instruction that occurred as early as elementary school, with 16% of students reporting their first negative mathematics instruction in grades three or four. This study assessed participating elementary math teachers' perceptions of their levels of math expertise and anxiety, provided coaching related to math content and pedagogy, and explored the extent to which that coaching makes a difference in terms of participants' confidence, efficacy, and anxiety.

Research Questions

This qualitative study addressed the following research questions:

1. How do participating elementary teachers describe their experiences with mathematics and mathematics teaching?
2. How do the participating elementary teachers describe their level of mathematics anxiety?
3. To what extent can a tailored and differentiated mentoring and coaching program affect participating elementary teachers' mathematics teaching efficacy?

Definitions of Terms

For the purpose of this study, the following definitions are used:

Math anxiety: Negative perceptions, avoidance behaviors, and feeling pressured and inadequate in their mathematics ability that combined interfere with solving real world math problems, as well as academic math problems (Vahedi & Farrokhi, 2011).

Metacognition: Knowledge concerning one's own cognitive processes and products or anything related to them (Flavell, 1976).

Teacher personal concepts: How teachers viewed the study, acted, and processed elementary math, and their confidence in their ability to teach elementary mathematics (Patton, et al., 2008).

Pedagogical content knowledge: Understandings of the subject matter, which included: the ability to anticipate and respond to typical student patterns of understanding within a content area and the ability to create multiple examples and representations of challenging topics that make the content accessible to a wide range of learners (Grossman, Schoenfeld, & Lee, 2005, p20).

Limitations of the Study

This study was limited to participating elementary teachers at a rural elementary in West Virginia and took place during the 2017-2018 school year. The study focused on participants' attitudes, perceptions, abilities, confidence in teaching, and anxiety for mathematics. A qualitative research approach compared teachers' math perceptions, attitudes, confidence levels, and anxiety levels prior to the mentoring and coaching professional development program and upon completion of the program. This study did not investigate student scores on mathematics assessments at any time during the professional development program, nor did it investigate the teachers' mathematics content knowledge. This study is unique to this school.

CHAPTER TWO: LITERATURE REVIEW

The key themes in this review of the literature are: math anxiety; current content expertise requirements for elementary math teachers; math anxiety felt by teacher candidates and teachers; sources of math anxiety in elementary students; teacher preparation programs; undergraduate elementary education programs that emphasize mathematics education more effectively; effective pedagogy for elementary mathematics students; teachers' perceptions regarding mathematics and teaching mathematics; coaching teachers in the classroom setting; improving mathematics achievement in students; and professional development for mathematics teachers.

Math Anxiety

A recurring theme in elementary math education is math anxiety. Peker and Ertekin (2011) found a link between experiencing mathematics anxiety and feeling anxious about teaching mathematics. They found that teachers who were more afraid of doing mathematics were more likely to fear teaching mathematics. This fear of teaching mathematics could lead to avoiding math in the classroom, a behavior that can be detrimental to the current and future mathematics achievement in their students. Research has shown that teacher behavior is a prime determinant of math anxiety in students and is usually evident in the primary grades (Jackson & Leffingwell, 1999). According to Hembree (1990) and Ramirez et al. (2013), there is a strong negative affect on students' mathematics achievement when the teacher is experiencing math anxiety.

Wu, Barth, Amin, Malcarne, and Menon (2012) demonstrated that math anxiety in primary grade children was present in second grade, and that it had a detrimental effect on the students' future mathematics achievement. Maloney and Beilock (2012) stated the problem of math anxiety very clearly when they demonstrated that not only is math anxiety present at the

beginning of formal schooling—which, it is important to point out, is earlier than previously assumed—but that the development of math anxiety is probably tied to both a teacher's anxieties about their own mathematics ability and to a student's own basic numerical and spatial competencies. Lyons and Beilock (2012) found that math anxiety is a very real issue with a wide range of consequences. They found that math anxious people had the same negative reaction to doing mathematics as they did to the anticipation of a concrete feeling of pain, and that reaction could have consequences. Geist (2010) expanded on that point: "Since we tend to avoid pain, it is likely that math anxious people will work very hard to avoid mathematics" (p. 330).

Current Requirements for Elementary Math Teachers

What do elementary teachers need to know so that they are competent to teach mathematics? Since at least 2002, the United States Department of Education has demonstrated that a crucial disagreement exists on this subject. Some argue that a teacher's capability in general mathematics is the most important qualification; others believe that general mathematics ability must be complemented by additional professional knowledge, such as how to get students thinking about content or completing mathematical tasks. Hill, Schilling, and Ball's study (2004) provides evidence for the conjecture that content knowledge for teaching mathematics consists of more than the knowledge of mathematics held by any well-educated adult. While this knowledge level of mathematics is an important component of the knowledge needed for teaching, there appears to be more mathematical depth to teaching mathematics in elementary school. Hill, et al.'s results demonstrate that instead of focusing on how much mathematics an individual knows, researchers must also focus on how an individual possesses and implements that mathematical knowledge, and whether or not a teacher can use that mathematical knowledge to generate representations, interpret student work, and analyze student mistakes. Hill et al.

(2005) astutely concluded that measuring teachers' basic verbal or mathematical abilities on performance tests may overlook key elements in what produces quality teaching.

Hill et al.'s (2004) results also bear weight on current policy debates regarding the recruitment, qualifications, and preparation of teachers. Hill et al. (2004) stated, "Strong knowledge of basic mathematical content does matter; however, policy makers must take seriously the idea that additional capabilities may be layered a top that foundation" (p. 27). Teachers need to know why mathematical statements are true, how to represent mathematical ideas in multiple ways, what is involved in an application, the definition of a term or a concept, and different methods for appraising and evaluating mathematical methods, representations, or solutions. Hitchison (1996) suggests that new mathematics teachers' perceptions of their weak pedagogical content knowledge may lead them to shift their teaching practices from conceptual to procedural/traditional, with which they may feel more safe and comfortable, but are significantly less effective. Geist (2010) mirrored this suggestion with his study.

Most teachers will not be able to shift their teaching practices from procedural to conceptual if they only meet current basic elementary mathematics teaching requirements. According to Harbison and Hanushek (1992), Mullens, Murnane, and Willet (1996), and Rowan, Chang, and Miller (1997), there have only been a few educational production function studies that have assessed teachers' mathematical knowledge and used it as a predictor of student achievement. Although, research has shown a positive effect of teacher knowledge on student achievement (Rowan et al., 1997). Pape, Prosser, Griffin, Dana, Alguires, and Bae (2015) concluded that the mathematics knowledge needed to carry out the work of teaching mathematics includes: evaluating students' responses, answering students' questions, creating assignments, and planning lessons, as well as differentiating instruction and communicating with parents and school building administration. Kilpatrick, Swafford, and Findell's (2001) study

stated that teachers of mathematics need to know more and different mathematics such as error analysis, recognition, and alternate strategies for teaching mathematics in order to efficiently teach mathematics to children.

The concern that teachers do not possess necessary knowledge and skills for teaching mathematics has also informed the development and use of teacher licensing exams, such as PRAXIS, an assessment developed by Educational Testing Service (ETS) and now administered in 37 states (Hill, Schilling, & Ball, 2004). Considering the development of such assessments, one might conclude that there is agreement about the levels of knowledge necessary for teaching mathematics to children. Even if that is true, there is not yet a concerted effort to increase the depth of knowledge possessed by elementary mathematics teachers. A close look at items released from the elementary mathematics portion of one PRAXIS teacher licensure exam suggests a lack of agreement over what teachers should and need to know to teach mathematics to their students. Some of the licensure examinations assess teachers' ability to solve middle-school-level mathematics problems, while others assess teachers' ability to construct mathematical questions and tasks for students; still other tests assess teachers' ability to understand and apply mathematics content to teaching (Hill et al., 2004). Hill and Ball (2004) concluded in their study of teacher content knowledge measures that the current tests only assess teachers' ability to solve problems, identify terms, calculate, and use formulas. They further concluded that the current content exams do not examine teachers' ability to unpack mathematical ideas, explain procedures, choose and use representations, or appraise unfamiliar mathematical claims and solutions—all specialized knowledge of mathematical content. Thus, the exams are not an adequate or complete way to measure teacher mathematical content knowledge.

Math Anxiety Felt by Teacher Candidates

Teacher candidates hold beliefs about math based on their own experiences as learners of math. There is a growing body of research on the strength of teacher beliefs and the part those beliefs play in the methods teachers choose to implement in their classrooms (Golafshani, 2002; Fosnot & Dolk, 2002; Wiersma & Weinstein, 2001; Sellers & Ahern, 2000; Yackel & Cobb, 1996). More recent studies (Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2009; Artzt, 2012; and Artzt, Armour-Thomas, Curcio, & Gurl, 2015) demonstrate that Hembree's (1990) findings, which revealed elementary education students exhibited the highest levels of math anxiety among undergraduate majors, still hold. Those elementary education majors must go on to teach students the foundational blocks of math and eventually, higher mathematics such as algebra. Those foundation blocks help build students' academic careers, lead to the creation of students' dispositions toward math, and influence students' perceptions that they "can" do math.

Teachers who do not feel comfortable with mathematics or who have math anxiety may be less likely to incorporate math into their daily teaching plans. According to Sloan (2010), teachers who reported a dislike of math spent 50% less time teaching it. This is a critical finding. Johnson and VanderSandt (2011) found similar results with their study regarding teachers who feel math anxiety and lean toward a likelihood of skipping mathematics instruction time. Sloan (2010) also found that teachers with negative attitudes toward mathematics frequently rely more on teaching skills and facts while neglecting cognitive thought processes and mathematical thought processes as well as mathematical reasoning which in turn fosters feelings of math anxiety in students which in turn continues the negative cycle of math anxiety.

Geist (2015) completed a study to examine teacher attitudes towards mathematics and how it may influence what they teach in the classroom as well as how they teach it in their classroom. In that study, he found that math anxiety affects how teachers assess their own ability

at mathematics: the more math anxiety a teacher reports, the lower that teacher rates their own ability at mathematics. The opposite is also true: the more mathematics a teacher feels they know, the more confident that teacher is in their own abilities with mathematics and the less they experience math anxiety.

In research focused on the causes of math anxiety, Kulkin (2016) found the following major contributors to math anxiety: communication and language barriers, quality of instruction, evaluation methods, difficulty of materials, and negative attitudes that can be inadvertently communicated by teachers and parents who are themselves afraid of math. Together, these contributors to math anxiety can be traced back to the elementary classroom and can best be eliminated or improved on in the primary grades. An Education Week blog even suggests that the beginnings of math anxiety in students can often be traced to the day they go to school and learn about fractions (Heitin, 2015).

Sources of Math Anxiety in Elementary Students

Research has determined that elementary teachers report having math anxiety and that this math anxiety has a negative influence on students' learning. What is not well known is how teachers' math anxiety affects the learning of students, nor what causes young students to become math anxious as well. Beilock, Gunderson, Ramirez, and Levine (2010) found that young female students in classrooms with math anxious female teachers were more likely to model themselves after their own teachers and therefore, assume the traditional gender stereotype that women are bad at math. Other studies suggest that math anxious teachers harm students' math learning by responding negatively and even angrily when students request help with mathematics problems (Cornell, 1999; Fiore, 1999; Jackson & Leffingwell, 1999).

Research has shown that math anxiety is the result of a student's previous negative or embarrassing experiences with math or a math teacher (VanderSandt & O'Brien, 2017). Math

anxiety has also been seen to develop early in elementary school (Harper & Daane, 1998). Jackson and Leffingwell (1999) reported that students had their first negative experiences as early as third or fourth grade. Geist (2010) concluded that the current educational policies of helping children develop fluency and computation and becoming more efficient at problem solving have, in reality, produced students who rely more on rote memorization and have thus increased levels of math anxiety in children by making mathematics a high-risk activity.

VanderSandt and O'Brien (2017) found that students remember struggling with particular math concepts and experiencing embarrassment in front of their peers, which produces more math anxiety. Students are affected by the perceptions they have about what others believe of their intelligence, especially their peers and teachers (Ramirez, Hooper, Kersting, Ferguson, & Yeager, 2018). Finlayson (2014) concluded that teacher behavior in the classroom is a prime factor in contributing to math anxiety in students. More studies have shown that teachers with high levels of math anxiety are more likely to transfer this anxiety to their students (Finlayson, 2014; Vinson, 2001). In summary, the literature suggests that math anxious teachers may create a learning environment that produces math anxiety in their students as well.

Teacher Preparation Programs

As major efforts to reform K-12 mathematics reveal, the traditional approach for preparing elementary teachers to teach mathematics is not adequate (Conference Board of the Mathematical Sciences, 2001). Prospective elementary teachers need opportunities to develop deep understandings of the mathematics they will teach in schools, including mathematical topics related to the content strands of numbers and operations, data analysis and probability, geometry, and measurement (Conference Board of the Mathematical Sciences, 2001; National Council of Teachers of Mathematics, 2000). In a review of bachelor degree requirements in elementary education of West Virginia universities and others drawn from a list of similarly

ranked universities (College Choice), it was found that 21 out of 30 universities require fewer total math courses (math content and math methods courses) than total language courses (English/reading/writing); seven universities require the same number of total math courses as they do language courses; and two universities require more total math courses than language courses to earn a bachelor's degree in elementary education (Best Elementary Education Degrees, 2019). Elementary educators need more math courses than they are currently getting to ensure a deep level of understanding in mathematics. It is imperative that elementary teachers have a deep understanding of algebra, one that goes well beyond just memorized computational procedures. In the final report of the National Advising Panel, members stressed that algebra is a central concern because it is a gateway to later mathematical achievement (U.S. Department of Education, 2008). Fundamentally, student achievement in mathematics depends upon teachers' depth of knowledge in mathematics.

Ford and Strawhecker (2011) focused on implications from past research indicating that opportunities in teacher education preparation must include instruction that deepens mathematical knowledge, perhaps through the integration of math methods courses, with conceptually based content courses. The Conference Board of Mathematical Sciences (2001) concluded that many teachers had been convinced by their own education that mathematics is comprised of a succession of disparate facts, definitions, and computational procedures—all to be memorized. As a direct consequence, these teachers are ill equipped to offer a different, more thoughtful style of mathematics instruction for their own students.

Sellers (2004) pointed out that this thinking creates a vicious cycle of poor K-12 mathematics instruction and produces ill-prepared college students. Unfortunately, undergraduate education often does little to correct the problem. Sellers, later updated by Looney, Perry, and Steck (2017), went on to report that universities do not require enough

mathematics coursework to change the fate of elementary teachers. Wiersma and Weinstein (2001), Smith (2008), and Bullock (2013) reported on a variety of models of mathematical sophistication and found research to substantiate the claim that most pre-service and in-service elementary teachers are at a low level of mathematical sophistication. Furthermore, they found that those teachers at low levels of sophistication have difficulty understanding reform methods of teaching mathematics and are least likely to be prepared to become effective mathematics teachers. Studies that show linkages between a teachers' lack of mathematical understandings and patterns in their mathematics instruction set the stage for policymakers' concerns about the mathematical quality of classroom work (Cohen, 1990; Heaton, 1992; Putnam, Heaton, Prawat, & Remillard, 1992; Stein, Baxter, & Leinhardt, 1990). The authors of these studies observed significant mathematics errors or imprecisions during classroom instruction ranging from inappropriate metaphors for mathematical procedures (Heaton, 1992) to incomplete definitions (Stein et al., 1990) to plain mathematical mistakes (Putnam et al., 1992).

Undergraduate Elementary Education Programs that Emphasize Math Education More Effectively

There are passionate debates about how to best produce high-quality teachers, especially math teachers (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009). VanderSandt and O'Brien (2017) completed a study on teaching styles and their impact on math anxiety. They found that teaching style had a substantial positive impact on math anxiety. Moreover, a Problem-Based Learning (PBL) style of teaching exhibited statistically significant decreases in math anxiety and medium to large practical differences while a direct teaching style either had no impact or a detrimental impact on anxiety. The PBL style of teaching is defined by five important elements: unstructured problems are presented, a student centered approach in which students determine what they need to learn, teachers acting as facilitators in the learning process, authenticity forms

the basis in the selection of problems that are cross-disciplinary, and an emphasis on group work (Hmelo-Silver & Barrows, 2006; Barrows, 2002). By comparison, the direct teaching style utilized in VanderSandt & O'Brien's (2017) study involved explicit and direct instruction where the teacher serves as the primary provider of knowledge and explanations. This style of teaching did not show a significant decrease in math anxiety.

An alternative pathway to produce more effective elementary mathematics teachers was created in California where universities developed courses for prospective teachers that blend mathematics pedagogy and content. The blended mathematics course uses a combination of instructional formats emphasizing the most appropriate format for the specific topic. The blended math course also utilizes a collaborative learning approach and provides prospective teachers the opportunity to work with students in field experiences in their actual classrooms and then reflect on the experience (Morales, Anderson, & McGowan, 2003). The blended math course emphasizes pedagogical content knowledge, through the mathematical development of ideas and topics, utilizing hands-on manipulatives and problem solving oriented investigative activities, in cooperative group and individual settings. In addition to an investigative approach to mathematics, the blended math course includes research-based discussions of how elementary students learn mathematics to help teachers further understand the difficulties students may have in learning mathematics (Morales, et al., 2003). The course was also designed to give prospective teachers an opportunity to practice applying their pedagogical content knowledge through structured teaching experiences. Morales et al. (2003) found that the experience of the blended math course resulted in students looking forward to taking the course because they felt like they were really learning how to teach mathematics.

Boyd et al. (2009) found one notable aspect of teacher preparation programs that consistently related to improved student outcomes. Teacher preparation that focused on the work

of the classroom and provided opportunities for prospective teachers to study what they will be expected to do as first-year teachers seemed to produce teachers who, on average, are more effective during their first-year of teaching. A few examples of such opportunities include providing more oversight of student teaching experiences and requiring a capstone project. Boyd et al. (2009) went on to conclude that teachers who have had the opportunity in their preparation to engage in the actual practices involved in teaching (e.g. analyzing student math work or planning a guided reading lesson) also show greater student gains during their first year of teaching. Learning, therefore, needs to be grounded in the practice of teaching. High quality mathematical education of teachers is the responsibility of both teacher preparation programs and school districts that employ these teachers once they graduate. The collective goal of higher education institutions, school districts, and the teachers themselves needs to be continual improvement in the preparation of mathematics teachers and the ongoing education of graduates, even after they become teachers (The Mathematical Education of Teachers II, 2012).

What Works for Teaching Mathematics to Elementary Students

Mathematics teachers, even elementary school mathematics teachers, must be well-prepared professionals who are skilled in both content and pedagogy (Darling-Hammond, 2000; Sharp, Bonjour, & Cox, 2019). Traditionally, students have been exposed to a great deal of "drill and kill" and "show and tell" mathematics instruction throughout their school experiences which have hindered their opportunity to learn mathematics from effective teachers (Hattie, Fisher, & Frey, 2017). Hattie and colleagues emphasized that mathematics instruction should consist of collaborative learning opportunities, rich discussions about mathematical concepts, excitement over persisting through complex problem solving, and the appreciation of ideas to situations and problems that matter.

To ensure effective pedagogy for elementary mathematics students, one must embrace a model of instruction that is rigorous, student centered, and fosters inquiry among students (Hoffer, 2012; Newton, 2016; Wedekind, 2011). A good example of such pedagogy is the math workshop approach. The math workshop approach transforms classrooms into mathematical communities of learners who engage in meaningful tasks within a math-rich learning environment (Newton, 2016). Research has shown that this teaching approach, where students develop conceptual understandings in mathematics by completing inquiry-based tasks in small groups while utilizing dialogue and reflection, is successful (Hoffer, 2012).

If an elementary mathematics teacher is expected to implement effective pedagogy to teach mathematics to students, they must have a deep knowledge of the content in elementary mathematics, and a strong sense of self-efficacy in teaching elementary mathematics. Elementary mathematics teachers can develop their content knowledge, pedagogy knowledge, and self-efficacy in teaching mathematics through a deepened teacher preparation program that focuses on both content and pedagogy and through embedded professional development with academic math coaches.

Teachers' Perceptions Regarding Mathematics and Teaching Mathematics

As previously stated, teachers' perceptions regarding mathematics and teaching mathematics can positively or negatively affect their students' perception of mathematics and learning mathematics. Thompson (1992) argued that it is important to study teacher beliefs and perceptions because teachers frequently treated their beliefs and perceptions as their knowledge, and that teachers' beliefs and perceptions had a direct impact on their experiences and practices in the classroom. According to Latterell & Wilson (2016), pre-service elementary teachers hold a variety of beliefs about mathematics and mathematics learning, such as the usefulness of mathematics, the depth of understanding required to teach mathematics, and even their like and

dislike for the subject. Their beliefs about mathematics lead to a variety of actions once they are in their own classrooms that can include minimizing time spent on mathematics, completing worksheets instead of hands-on activities, or skipping mathematics all together. Latterell & Wilson (2016) also point out that teachers' beliefs affect the beliefs of their students which can lead to students learning to be anxious about mathematics. They provide examples in their research to support this claim: "If students do not see math as something useful and something they are capable of doing, they will not put forth the required effort to learn math" (p. 3). Latterell and Wilson (2016) go on to conclude that how pre-service elementary teachers view math has a direct influence on how they will eventually teach math, which in turn influences elementary students' learning of math. Geist (2015) reached a similar conclusion: "The more confident they [teachers] are in their math ability, the more important they feel math is in the classroom" (p. 328).

Patton et al. (2008) pointed out some eye-opening negative perceptions held by elementary teachers in their study: "I really don't like math but I can teach it to elementary students without any problem," admitted one; said another, "It's just elementary school math; it's not like I'm teaching anything really difficult. Otherwise, no way I would do it" (Patton et al., 2008, p. 495). Patton et al. concluded that to effectively teach elementary mathematics, teacher candidates must unwrap their misconceptions about mathematics and mathematics teaching. Teachers' misconceptions about mathematics teaching stem from a belief system that tells teacher candidates it is easy to teach elementary mathematics because they have the declarative knowledge and procedural knowledge to answer basic mathematical problems. Teacher candidates' views and perceptions of mathematics, however, must be broadened to encompass how teachers can more effectively facilitate and interpret the nature of children's thinking. Patton et al. (2008) argue that it is time for teachers of elementary mathematics to stop

memorizing facts and to develop the metacognitive awareness needed to select appropriate mathematical strategies for learner success.

Coaching Teachers in the Classroom Setting

Teacher academic coaching is considered a high-quality professional development opportunity that emphasizes job-embedded practice, is intense and sustained, and emphasizes active learning (Desimone, 2009; Russo, 2004). Academic coaching, generally, involves observing teachers in their classrooms and providing feedback directed at improving their effectiveness as teachers (Blazar & Kraft, 2015; Wildman, Magliaro, Niles, and Niles, 1992). A number of studies have shown mostly positive outcomes resulting from academic coaching including those by Allen, Pianta, Gregory, Mikami, & Lun, 2011; Bruce & Ross, 2008; Campbell & Malkus, 2011; Marsh et al., 2008; Neuman & Cunningham, 2009; Sailors & Price, 2010. It is worth noting that research has shown positive benefits from academic coaching because studies of the effectiveness of school workshops and trainings, which are typical in teacher professional development, have produced mixed results (Blazar & Kraft, 2015; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007).

In education, academic coaching is most often described as using a multifaceted approach (Blachowicz, Fogelberg, & Obrochta, 2005; Coggins, Stoddard, & Cutler, 2003; Learning Point Associates, 2004; Smith, 2008) and is viewed to have a supportive role in teacher development (Galucci, DeVoogt Van Lare, Yoon, & Boatright, 2010). In most educational settings where coaching is utilized, instructional coaches work in non-supervisory roles (Taylor, 2008). Instructional coaches must use their expertise and foster relationships to exert influence. In addition, instructional coaching is content based (e.g. math coaching) and is intended to support teachers in meeting the aims of district reform (Neufeld & Roper, 2003). Knight (2005) states

that coaching roles often involve a delicate balance between coaching or mentoring responsibilities and whole school improvement.

The need to raise low student test scores, especially in reading and mathematics, is a common focus of education reform efforts across the United States but is especially concerning in schools that fail to meet Adequate Yearly Progress (AYP) (Hartman, 2013). In rural schools, raising low mathematics test scores can be a difficult concern to address. How do schools raise student test scores while also facing budget cuts and losing teachers? In these scenarios, utilizing an academic instructional coach as a form of professional development can be beneficial. Academic instructional coaching programs place an individual who is highly knowledgeable in both content and pedagogy within the school, in hopes of positively influencing teachers' planning, classroom instruction, and assessment techniques, and thereby increasing student achievement (Hansen, 2009; Hartman, 2013; Hull, Balka, & Miles, 2009; Knight, 2005; Marsh et al., 2008; Obara, 2010). Academic instructional coaching is rarely the same from one school district to another due to the unique needs of each district (Marsh et al., 2008; Obara, 2010). Regardless, coaches most often have the common goal of increasing student achievement (Hartman, 2013). To obtain this goal, academic instructional coaches must change the culture in the school in which they work. Ultimately, they must initiate, cultivate, and sustain collaborative positive relationships with their teachers (Hartman, 2013).

The nation's switch of focus to accountability within the education system has energized academic coaching (Driscoll, 2008; Knight, 2005; Moxley & Taylor, 2006; Obara, 2010; Showers & Joyce, 1996). Academic coaching evolved in response to teachers' concerns over the inadequate professional development they were receiving (Hartman, 2013). Teachers reported that professional development sessions had low amounts of transfer to their instructional techniques, and they advocated for a new means of embedded professional development (Joyce

& Showers, 1981). The researchers then studied what happened when teachers engaged with an academic coach as part of professional development and found that the teachers were more likely to improve their instruction by adopting new ideas and practices (Hartman, 2013; Showers & Joyce, 1996). Proponents of academic coaching suggest that coaches provide professional development in a more integrated manner than the usual day-long in-service session, or after/before school meetings (Chval et al., 2010; Knight, 2005; Neufeld & Roper, 2003). A key factor in favor of academic coaching is that it provides support within a regular school day rather than a special occasion (Chval et al., 2010).

There is evidence to support the concept that academic coaching can increase the instructional self-efficacy of teachers. Marsh and colleagues (2008) completed a study of literacy coaches in Florida and found that two thirds of the reading and social studies teachers who interacted with coaches believed coaching helped them to become more confident in their teaching abilities. Bruce and Ross's (2008) qualitative study of third and sixth grade peer math coaches found that teachers who engaged in peer coaching partnerships experienced an increase in their beliefs about their abilities as math teachers. This same study also found that the teachers felt their students were performing better due to the academic math coaching. The findings from both studies, Marsh et al. (2008) and Bruce & Ross (2008), suggest that academic coaching can increase teacher self-efficacy and have a positive effect on the quality of instruction while increasing student achievement.

Rush and Young (2011) found that the majority of teachers who participated in their research on academic coaching felt that spending professional development money on coaches was worthwhile, and they wished to continue the practice. Many school districts are embracing coaching as a model of professional development for teachers because the one-stop workshops and professional conferences that dominated teacher professional development for so long have

been proven an ineffective route for sustained instructional growth (Ball & Cohen, 1999). In recent research on coaching, it has been suggested that school-based mathematics specialists or coaches may help support the improvement of mathematics teaching and learning in elementary schools (National Research Council, 2001; Campbell & Malkus, 2011).

Neufeld and Roper (2003) defined the function of the mathematics coach as an agent who breaks the current culture of teacher isolation where teachers work in private and without meaningful observation or feedback. The mathematics coach can catalyze and sustain the implementation of content-focused work addressing mathematics curriculum, instruction, and assessment while supporting collective professional habits that advance school-wide growth as well as student learning and achievement (Campbell & White, 1997; Marzano, Walters, & McNutty, 2005; York-Barr & Duke, 2004). The rationale for the use of mathematics coaches is to increase effective teaching and is rooted in research on learning and on effective models of professional development (Campbell & Malkus, 2011). Campbell and Malkus go on to say that instructionally focused mathematics coaching targeted to individual teachers or grade-level teams may affect teacher knowledge, competencies, beliefs, and dispositions, thereby potentially yielding instructional change that influences student achievement. Mathematics coaches are placed in elementary schools to construct leadership roles and to provide professional development addressing mathematical content, pedagogy, and curriculum. Campbell and Malkus's (2011) study showed that over a three-year period, the students in their study who were enrolled in schools with an elementary mathematics coach had significantly higher scores on their state's high stakes standardized mathematics achievement tests (grades 3-5) than did the students in their control schools.

Research indicates that coaching works (Ball & Cohen, 1999). One peer coaching study in California included over 80 schools (Cornett & Knight, 2008). The researchers found that

when teachers were given instructional practices at one-shot professional development sessions, only 10% used that skill in their classroom. However, when coaching was added, about 95% of the teachers implemented the newly learned material. Embedded professional development supported by an instructional coach is a promising strategy for addressing the needs of improvement in high quality mathematics instruction (Taylor, 2008; Gallucci et al., 2010). Reflective of the positive results from research on coaching, it is becoming increasingly common for coaching to be the vehicle to achieve instructional improvement (Galucci et al., 2010).

Improving Mathematics Achievement in Students

Much research has focused on how to increase student achievement in mathematics. Importantly, this improvement needs to occur at the elementary level. The Conference Board of the Mathematical Sciences (2001) argued that "It is during the elementary years that young children begin to lay down those habits of reasoning upon which later achievement in mathematics will crucially depend" (p. 11). Kulkin (2016) concluded that adults who want to help students with mathematics will be richly rewarded if they choose to entice students with tangible problems that relate to everyday life. Kulkin also focused on increasing student excitement about mathematics by engaging them in positive math experiences: "The excitement generated by even one positive math experience may turn some of our math-shy participants into the creators, designers, and problem solvers of the future" (p. 32).

Teachers' mathematics ability also comes into play as influential in raising student mathematics achievement. Kramarski, Mevarach, and Arami (2000) completed research to support the idea that a teacher's ability to embed multi-level metacognitive training for third graders significantly improves students' math achievement. Locangeli and Cornoldi (1997) also concluded that successful mathematical performance depends upon metacognition. In their research, Patton et al. (2008) focused on a new trend in which state academic tests provided

many situational-type problems accompanied by sketches or illustrations. The successful student in these tests will have been taught how to interpret the situational problem or text. The sketches may require the learner to metacognitively process the sketch in a variety of ways. A teacher who possesses a deep understanding of mathematics will be better equipped to teach their students how to analyze such problems. Other researchers (Hill et al., 2005; Mullens et al., 1996; Rowan et al., 1997) identified the unique contribution of teacher knowledge to student achievement. Researchers have long identified the fact that teacher subject knowledge has an impact on instruction. (Borko et al., 1992; Fenema, & Franke, 1992; Leinhardt & Smith, 1985; Putnam et al., 1992). This combination provides evidence of the proposition that stronger teacher knowledge yields positive benefits for classroom instruction and student achievement (Hill et al., 2004).

Professional Development for Math Teachers

Research has shown that deepening the teacher's mathematical understanding, reducing the teacher's math anxiety, and improving the teacher's negative beliefs and perceptions regarding mathematics and teaching mathematics can have a positive impact on elementary students' mathematics achievement, math anxiety, and math perceptions. Professional development can improve teachers' content knowledge, level of comfort with mathematics, and the repertoire of methods they utilize in their classroom. Hill et al. (2004) pointed out that by helping teachers develop deeper knowledge of mathematics that goes beyond the basics needed for everyday non-professional functioning, university faculty and professional development professionals may assist teachers in preparing for the tasks they will encounter on the job. Hill, Schilling, and Ball's research supports professional development and teacher preparation programs that enable this kind of learning. Significant research has also been done to examine professional development designed to promote successful mathematical teaching methods. The

Conference Board of the Mathematical Sciences (2001) committee suggested that teachers must learn to make sense of mathematics. Teachers must move toward possessing higher order thinking skills, generalizations, and rigor that may not have been present in their own elementary education (Sellers, 2004). "It is clear," Sellers (2004) writes, "that teachers can no longer afford to be ill-prepared to teach math, even elementary, by means of the traditional mathematics lecture courses" (p. 51). Althauser (2010) found that professional development can fill this gap for teachers lacking early math learning. If teachers expect to effectively teach their students how to become problem solvers, they must become problem solvers. Althauser's (2010) study of a job-embedded professional development initiative that took place over a two-year period with thirty-five teachers concluded that in general there is a relationship between teacher efficacy and student mathematics achievement.

Sellers (2004) also recommended different focuses for the professional development of elementary mathematics teachers, some of which included focusing professional development to enhance the teacher's ability to: deepen their elementary students' thinking and reasoning, guide mathematics exploration by asking deeper questions, direct and emphasize good mathematical thinking, and create classroom environments where mistakes are motivations for learning. Sellers (2004) concluded "Poor mathematical students have difficulty trusting their own ability to plan these kinds of lessons or to carry them out with actual students" (p. 52). Professional development can help teachers become more confident in preparing, planning, and implementing more real-world problems, hands-on lessons, and problem-solving activities in classrooms. Research has shown the best way to create these kinds of learning environments is to create professional development classrooms that bring these elements to life for teachers. (Sellers, 2004)

Summary

This literature review focused on the key themes of this study: current requirements for elementary math teachers, math anxiety felt by teacher candidates and teachers, teacher preparation programs, teachers' perceptions regarding mathematics and teaching mathematics, improving mathematics achievement in students, and professional development for mathematics teachers. An abundance of research has been completed on math anxiety, math anxiety felt by pre-service and in-service teachers, insufficient teacher preparation programs, and professional development to aid teachers in gaps they may find that they have in mathematics content knowledge and problem-solving teaching methods. These are all crucial concerns that need to be addressed to ensure increased effectiveness of elementary educators and thus improve the mathematical understanding their students possess. Teacher content knowledge, attitudes toward mathematics, and self-efficacy have become increasingly important issues in mathematics education (Amato, 2004; Ball, Hill, & Bass, 2005; Swars, Hart, Smith, Smith, & Tolar, 2007; Evans, 2011). According to the National Research Council's report *Adding It Up* (2001), today's students will face new demands for mathematical proficiency that educators should attempt to anticipate. They go on to point out that math is a realm no longer restricted to a select few, that all young Americans must learn to think mathematically, and that they all must think mathematically to learn.

CHAPTER THREE: METHODS

This study was a qualitative methods study designed to collect and analyze data from open response items on the Initial Open-Ended Survey (Appendix C), small and large group training sessions, discussion groups, observations, one-on-one coaching, co-teaching, and interviews. Data analysis also included participants' opinions, feelings, responses, and self-reported levels of math anxiety, math content knowledge, and confidence in teaching mathematics.

Research Design

A methodology provides a piece of research with its philosophy and becomes the approach for the study (Almalki, 2016). Dawson (2002) points out that methodology includes an overview, which considers the ethics, potential risks and problems, along with the limitations of any approach. The design of this study focused on determining the perceptions of the participants on teaching mathematics and mathematics anxiety. This study utilized a qualitative methods approach, where the researcher analyzed open response items, feelings, reactions, and observations.

The following research questions were examined and analyzed with intent to achieve the purpose of the study. They take into consideration the study's research design, the population surveyed, data collection techniques, and-methods used to analyze the data. The variables in each question were taken into consideration to ensure that this study would yield findings, conclusions, and implications that educators and school administrators would find useful, as well as indications for future research.

To achieve the purpose of this study the following research questions were examined and analyzed:

1. How do participating elementary teachers describe their experiences with mathematics and teaching mathematics?
2. What is the level of mathematics anxiety of participating elementary teachers?
3. To what extent can a tailored and differentiated mentoring and coaching program affect participating elementary teachers' mathematics teaching efficacy?

Population and Participants

The study took place at a rural elementary school in West Virginia. The elementary school with enrollment below 250 students in grades PK-5, had approximately 22 teachers and teachers' aides. The enrollment consisted of approximately 95% white students; slightly less than half the student population were male, and slightly more were female. Over half of the student population at the elementary school fell into the low SES category, and approximately one-fifth of the students were part of the special education category (WV Department of Education, 2018).

Initially, the idea for the study was inspired by my involvement in a professional development program for elementary school teachers who expressed reservations about their abilities to teach mathematics. The school, which is widely reported to employ great teachers who have previously been receptive to working with fellow educators and community members, provided the population for the study. Due to my previous association with the school, convenience sampling was used to identify participants. This study helped me realize the varied and deep needs of elementary teachers when they are teaching mathematics.

All teachers and teacher aides were invited and encouraged to participate in the study. At the initial meeting—which occurred during a faculty senate meeting—a detailed description and expectations for participation in the mentoring and coaching professional development program were presented (Refer to Appendix E). Participants were made aware that the purpose of the

mentoring and coaching professional development program was to help them overcome feelings of math anxiety and to help them feel greater comfort with their math content knowledge. Teachers were asked to identify concepts, methods, or topics that they wished to be covered throughout the professional development program. They were invited to ask questions about the professional development program that were answered at the initial meeting. The Initial Open-Ended Survey, which was given to determine the participants' perceptions regarding mathematics and teaching mathematics, was handed out after teachers adjourned their faculty senate meeting. While participation was entirely voluntary, only those who wanted to participate in the professional development, observations, interviews, and coaching were selected for participation in the study. The coaching sessions focused on either concept identified by participants for further learning or on different teaching methods useful in teaching the concepts.

Of the 20 participants (18 elementary teachers and 2 elementary teacher aides) in the study, 4 elementary teachers were interviewed, 3 elementary teachers were observed, and I co-taught with one elementary teacher. The four teachers that volunteered to be interviewed were comprised of new and experienced teachers from a cross-section of different grade levels, including kindergarten, third, fourth, and fifth grade. Interview participants were asked 18 essential questions and several follow up questions (Appendix D). Participants' names were replaced by the grade level they teach in order to protect their confidentiality. A list of all study participants is included in the Appendix (Appendix F).

The interview participants were:

- Kindergarten Teacher A – 0-5 years of teaching experience
- Kindergarten Teacher B –0-5 years of teaching experience
- Third Grade Teacher A –5-10 years of teaching experience
- Fourth Grade Teacher A –5-10 years of teaching experience

The teachers observed were:

- Second Grade Teacher A – 0-5 years of teaching experience
- Fifth Grade Teacher A –5-10 years of teaching experience.
- Fourth Grade Teacher B –5-10 years of teaching experience

The teacher I co-taught with was:

- Fifth Grade Teacher B –0-5 years of teaching experience.

All of the elementary teacher participants received their undergraduate degree from accredited universities in elementary education and are certified in kindergarten through sixth grade elementary education. All of the elementary teacher participants were required to take one math content course and three math methods courses to obtain their undergraduate degree in elementary education.

I conducted the observations, interviews, and coaching of the teachers at the participating elementary school. I have earned a Bachelor's degree in Secondary Education Mathematics (grades 5-adult), a Master of Arts degree in Leadership Studies (Administration, PK-Adult), and an Education Specialist degree in Curriculum and Instruction. I have ten years of teaching experience in West Virginia and Texas, and I have taught every high school level math course from Algebra 1 to AP Calculus BC. I am also a mother to a preschool aged toddler, an elementary student, and two middle school students. I have experience and knowledge in teaching mathematics to all ages, utilizing sound pedagogical and research-based strategies.

Every teacher at the participating elementary is a certified teacher and therefore, considered highly qualified. All 18 teacher participants hold a minimum of a Bachelor of Science degree in Elementary Education and 10 of them also earned a Master of Arts degree in education. The average amount of years of experience for the 20 participants was 14 years.

Instrumentation

The study began with each of the 20 participants completing the Initial Open-Ended Survey (Appendix C). The Initial Open-Ended Survey was obtained from a previous study by Geist (2015), that was used to measure teacher candidates' perceptions on math and teaching mathematics. Teachers' attitudes and perceptions regarding mathematics and teaching mathematics were measured by answering open-ended questions on the Initial Open-Ended Survey, such as:

- How do you feel when doing a math problem?
- What do you like and dislike about math?
- Why do you think math is important to learn in the grade you teach?
- Is it important for your grade to learn math skills; if so, why?

Asking open-ended questions helped me to understand participants' understanding about math, teaching math, and math anxiety, and to make sure that every teacher was heard.

In October of 2017, I scheduled an initial meeting with the participating teachers at the elementary school for January 2018, at the beginning of the new semester. Only 12 of the 18 teacher participants were present at this meeting because some of the teachers had trainings at their central office they were required to attend; both of the teachers' aides were present. The introduction to the meeting included the details of the coaching and mentoring program. The participants were informed that I would conduct trainings on math content, concepts, strategies, and methods that they themselves would choose, and ones that their administrator may suggest.

The mentoring and coaching program tailored to the needs of the participants was developed by utilizing the data participants reported on the Open-Ended Survey to construct trainings on math concepts and teaching strategies and by observing the participants' math classes to better understand the participating teachers' perceptions and attitudes regarding

mathematics and teaching mathematics. Throughout the mentoring and coaching professional development program, the participating teachers were involved in bi-weekly training sessions and discussions to help them build their content knowledge in mathematics, increase their confidence in teaching mathematics, and create lessons that could help students connect previously learned concepts to new ones.

The professional development trainings varied based on the needs of participants. The data that the participating teachers provided in the Initial Open-Ended Survey guided the content of the initial trainings, and data gathered throughout the semester from observations, one-on-one conversations, and subsequent group discussions provided the content of the remaining training sessions. The training sessions were conducted by the researcher in both large group settings and small group settings. The training sessions covered topics on math content and strategies to teach the math content, such as fractions, ratios, math stations, units of measurement, and factors. After each training, I completed field notes to document how the training went and what I observed from the participants. In the notes, I detailed how the participants communicated, participated, and reacted, as well as their expressions, stances, and body language throughout the training. I also included quotes from the participating teachers.

The co-teaching aspect of the professional development program was spontaneous and emergent, and involved myself helping any teacher that reached out to me and asked for my assistance in planning and co-teaching a particular lesson. When I co-taught a lesson with one teacher, we planned the lesson together based on an upcoming concept she was required to teach but felt she could use some guidance to ensure that her students would learn the concept. After we planned the lesson we-co-taught it, utilizing each other's strengths to better help more students. Upon the completion of the lesson we had a quick debrief of how the lesson went, what I may had done differently than the teacher, any questions the teacher may have had, any

suggestions I had for the teacher, and how the teacher could move forward. Afterward, I would complete detailed notes regarding the entire process.

Throughout the semester professional development program, I also conducted observations of the participating teachers during their classroom math instructional time. Detailed field notes regarding what math concept the teacher was teaching, how the lesson was conducted, how the students interacted with the teacher during the lesson, and what teaching strategies the teacher utilized were taken during each observation. Observations were used to monitor math lessons, teacher content knowledge, teacher explanations, classroom depth of knowledge, different levels of mathematics anxiety present in the classroom, and teachers' mathematics teaching efficacy.

The coaching aspect of the professional development program consisted of discussions after the large and small group trainings, discussions that were one-on-one with teachers, and debriefing a co-teaching session. During a coaching session or moment, I would listen to teachers' needs, wants, and concerns while providing them with helpful tips, answers to math content questions, multiple ways to complete the math content they were currently working on, and suggestions on how to increase their overall mathematics teaching efficacy.

The data collected from analyzing the Initial Open-Ended Survey responses, the small and large group trainings and discussions, coaching sessions, co-teaching, observations, and interviews was analyzed using a grounded theory approach for qualitative data to search for commonalities and themes.

Data Collection Procedures

Approval to collect data using the Initial Open-Ended Survey, the field notes from training sessions, discussions, observations, and interviews was obtained from the Marshall University Institutional Review Board (IRB) (See Appendix B). Once approved, data was

collected by handing out a printed copy of the Initial Open-Ended Survey to participating teachers after a faculty senate meeting in January of 2018. Twelve teachers and two teachers' aides completed the survey at this meeting and six teachers completed the survey at the next faculty senate meeting. A cover letter was attached to the Initial Open-Ended Survey describing the purpose and rationale of the study. The cover letter also confirmed the privacy and confidentiality of participants and ensured no identifying markers would be shared. An explanation of the study, its relevance to the school, and impact on education in general was outlined in a PowerPoint presentation delivered to all teachers and teachers' aides at the participating elementary school. The PowerPoint also included the approval and encouragement of the school's principal to start the professional development program and a review of research studies that examined math anxiety, its prevalence in elementary classrooms, and its role in teachers' perceptions about teaching math. The Initial Open-Ended Survey was coded using the grounded theory approach for qualitative methods. Every question was individually examined and each participants' response was coded for similarities and themes. The small and large group trainings were meticulously recorded in field notes. The entire process for the trainings was recorded, but more importantly the responses and reactions from the participants were detailed in field notes. The field notes were later analyzed in much of the same way as the Initial Open-Ended Survey using the grounded theory approach.

During observations, field notes recorded which participant was being observed, what math content was being covered, and descriptions of the classroom environment. The field notes included the participating teachers' body language throughout the observation, any math anxiety perceived by the observer, vocabulary used, and how comfortable the teacher seemed to be facilitating the lesson and answering student questions. The collected data also included the

students' reactions to the teacher's lesson. All field notes from observations were analyzed looking for the common themes as they emerged throughout the study.

Data collection occurred during one semester from approximately January 4, 2018 to June 5, 2018. To increase participation in the small and large group trainings and discussions, observations, coaching, and interviews, I positioned myself at the participating school once every two weeks throughout the semester. I helped to plan math lessons, helped to teach math lessons, and held small and large group trainings and discussions to provide support, knowledge, and resources that would ensure an increase in participants' math content knowledge and confidence in teaching math, to decrease any math anxiety they may have felt, and to hopefully improve overall teacher efficacy.

Data Analysis

The data was analyzed using qualitative methods to describe and interpret the participants' answers to survey questions, interview questions, observations, small and large group trainings and discussions, and co-teaching. The qualitative methods approach of grounded theory was used for data analysis to identify emergent themes and code data based on those themes. I read and re-read all data, field notes, and responses numerous times to determine prevalent and recurring themes in the data. As a result, I fully saturated my thinking with the beliefs, ideas, feelings, perceptions, experiences, reactions, and anxiety levels expressed by teacher participants regarding the teaching and learning of math.

Methodological Strengths and Weaknesses

The qualitative methods used for this study, such as the Initial Open-Ended Survey, interviews, small and large group trainings and discussions, observations, co-teaching, and coaching, were uniquely selected to ensure that the data were analyzed using a grounded theory

approach with an open mind set in order to best understand concepts that emerged from the data. The Initial Open-Ended Survey, given to participants at the first meeting, had three components. Questions one through four were designed to gauge the participants' attitude toward mathematics, questions five and six were designed to gauge the participants' beliefs about the importance of teaching mathematics, and questions seven through nine were designed to investigate participants' beliefs about how mathematics is taught in the classroom (Geist, 2015, p. 332) (Appendix C).

Small and large group trainings and discussions, observations, mentoring, and interviews allowed the researcher to gather a greater depth of data pertaining to the participants' math anxiety, their perceptions and beliefs regarding mathematics and teaching mathematics, and their levels of comfort in their mathematical content knowledge. The small and large group trainings produced data regarding the participants, the presence of math anxiety, confidence levels, and reactions to the math content and training. The small and large group discussions produced data on the participants' self-reported math anxiety, perceptions and beliefs regarding mathematics and teaching mathematics, as well as their comfort levels in their own mathematical content. The field notes taken from classroom observations and one-on-one mentoring provided the same data but at a more individual level. That said, both the data and interpretations were limited to these participants, in this particular case. In addition, the study was limited by the following factors: a small sample population of approximately 20 teachers at a singular school set in a rural location. This study is unique to this school.

CHAPTER FOUR: PRESENTING AND ANALYZING DATA

Initial Meeting

All participants were requested to fill out an Initial Open-Ended Survey (Appendix C) so I could have a better understanding of their predispositions to math and teaching math, their perceptions of math and math anxiety, and their needs and wants from a coaching and mentoring program. Some of the questions included on the Initial Open-Ended Survey were: How do you feel about doing a math problem; What do you like about math; What do you dislike about math; What do you need to know about math to teach it to young children; and Why do you think math is important to learn in the grade you teach. A printed copy of the survey was provided to each participant on which they were to write their detailed answers.

I will share their answers, but first I want to describe the group discussion that took place around some of the concepts they wanted—the coaching and mentoring program to teach, review, and to demonstrate different methods to teach math content. I deliberately opened the discussion to see where it would lead; once the discussion began to veer off topic I introduced the next question I wanted them to discuss. I asked the group of participating teachers, "How many teachers in here feel they were adequately prepared to teach the math content in their grade?" Out of the 12 teachers present, three raised their hands. Next, I asked if anyone would like to give an example of a math standard they felt prepared to teach. One brave teacher raised her hand and said, "I am a third grade teacher and when it came to teaching fractions, I wasn't ready. I need help. I feel we all need a better way to teach fractions." She went on to say, "I wish I could have taken a content course on fractions, how to order them from smallest to largest, and how to find common denominators, how to add and subtract fractions, and how to divide them! All of that!" Fifth Grade Teacher A then added, "I need to be a master of fractions

in order to teach my students how to be masters at them. I never even took a class that covered fractions in college!" All of their colleagues agreed with a resounding "Yes!"

The third, fourth, and fifth grade teachers expressed the most concern about not feeling prepared to teach math to their students. They felt that their one college algebra course was pointless because they, for the majority, struggled through it and as a result, do not teach algebra. Fourth Grade Teacher B said, "It would have been much more beneficial, for me as an elementary teacher, to take courses on fractions, converting measurements, factors, money, and how to teach those concepts to students."

I asked the entire group of teachers if they could suggest topics and concepts-to cover in a professional development program, what would they choose? Slowly, teachers began suggesting topics with which they wanted more help and that they valued. Some of the topics and concepts the teachers mentioned were:

- Math stations: A new method for teaching math their county administration began pushing for the school year to be implemented in every grade.
- Fractions: Strategies for finding common denominators and equivalent fractions; adding and subtracting fractions, and multiplying and dividing fractions
- Units of Measurement: Approaches for finding equivalent units of measurement and conversion to different units of measurement.
- Multiplication facts: How to ensure skill development that could ensure students' memorization of multiplication facts.
- Factors: Strategies for finding factors between numbers.
- Money: Suggestions for multiple and fun ways to teach monetary concepts.

After we discussed specific concepts they would like the trainings to cover, they also expressed the need to know multiple ways to teach those concepts.

The end of our discussion focused on math anxiety and whether they or their students had experienced it. I asked the group, "Do you believe elementary educators experience math anxiety?" Most teachers nodded their heads, and one teacher said, "I think that some teachers may be reluctant to admit it, but fractions intimidate them, especially teaching them." A teacher that taught fifth grade the prior year, Kindergarten Teacher A said, "I definitely had math anxiety my entire first year of teaching fifth grade. I was nervous I was going to mess up in front of my students and end up confusing them even more!"

After hearing these statements, I asked the participants to offer suggestions that, in their view, could eliminate or reduce a teacher's math anxiety about teaching math in the elementary classroom. The participating teachers offered the following list of suggestions:

- Covering the more difficult content better in college; for those that are already teaching, providing professional development that teaches and reviews difficult content while also providing multiple ways to complete the type of problem.
- Providing certified math teachers at every elementary school to be the permanent third, fourth, and fifth grade math teachers.
- Providing coaches or mentors to work one-on-one with new teachers on how to create and implement math lessons with efficiency and confidence.

Upon the completion of the first meeting and discussion with participating teachers, I felt confident that I had a great foundation of where to start with the mentoring and coaching program in January. After I searched for themes, then analyzed and coded the participants' responses to the questions on their Initial Open-Ended Survey searching for themes, I had even more information to create the best and most efficient coaching program for the participants.

Thirty-three percent of the participants wrote that they felt the most important things teachers need to know about teaching math to young children is that there are multiple ways to

solve a problem. Twenty-five percent felt that the most important things teachers need to know about teaching math are the math fundamentals: adding and subtracting, multiplying and dividing, and fractions. Interestingly, 83% of the participating teachers liked math because it can be hands-on, people use math every day, math teaches problem solving, math has direct real world relations, it is fun to teach, and because they themselves had a great math teacher at one point. The greater majority of the participants, 66%, believe that it is important to learn math at the grade in which they teach to build and to stabilize a child's foundation in math; 17% of the participating teachers believe that the grade-level math they teach is important because it is a part of daily life.

One of the questions on the Initial Open-Ended Survey asked teachers to explain how they would teach math to a first-grade child. This question was designed to determine what the participant felt was important to acknowledge first when teaching math to a first-grade child. Fifty percent of the teachers stated they would use manipulatives, and 25% stated they would use a lot of repetition and modeling. However, 8% of the participating teachers admitted they did not know where to start to teach a first-grade child math. Even with these challenges, after analyzing the participating teachers' answers, it became evident that most teachers are on the right track as to what is important to remember when teaching math to young children. Fifty percent of the teachers stated when teaching math to young children it is important to remember all children learn at different rates, in different ways, and at different levels. Fifty percent also felt it is important to remember to give students time to grasp new concepts before moving on and to make math fun and exciting for students.

Large Group Trainings and Discussions

Upon the completion of our discussion on the Initial Open-Ended Survey we moved to a large group coaching and training session on "Why" questions and "Show Me" and "Explain"

prompts. The purpose of the session was to demonstrate the importance of having students explain their thought processes, to show how they arrive at their answers, and to ask them why they choose a particular method to solve a problem. These questions force students to think, analyze, and problem solve. I demonstrated a simple student-teacher guided problem where I played the role of a teacher and the participating teachers played the role of student. I, as the coach, asked a volunteer to come to the board where she was instructed to find a common denominator for two fractions: three-fourths and 6/10. The teacher quickly responded, "20." The teacher gave the correct answer, but what did she learn from the problem? Nothing. What could another student that witnessed the problem, at the front of the room, learn from it? Nothing. However, if I, the coach, would have asked her to please explain how she came up with the common denominator of 20 for the two fractions of three-fourths and 6/10, then everyone listening would hear her thought process, and if someone was unsure of how to find a common denominator, they would now have an example to follow. Subsequently, we re-calculated the problem; but this time, I used my "Why" questions, and "Show me" and "Explain" prompts:

Coach: "What is the common denominator of the two fractions three-fourths and 6/10?"

Teacher: "20"

Coach: "How did you get that? Can you walk me through it?"

Teacher: "Yes, I know to get the common denominator of two fractions I can list their multiples and select the smallest one they have in common."

Coach: "Okay, what are the multiples of each denominator?"

Teacher: "4, 8, 12, 16, 20, 24,…" and "10, 20, 30, 40,…" "So, 20 is the smallest number that they both are a factor of. The common denominator is 20."

Coach: “Great! Now if a student didn’t have the correct answer on their own paper, they know why, or what they did wrong.”

If the teacher would have given the incorrect answers during her explanation, I could have determined what part of the process she needed help with; multiplication or the basic idea of finding common denominators. This small coaching session helped participating teachers to agree upon what they observed:

- “Why” questions, “Show me” and “Explain” prompts are a good practice.
- They forget to follow through with those items.
- They get rushed in day-to-day teaching and run out of time.
- They need to set up their lessons with time built in to do guided practice problems where students are expected to explain their thought processes and why or how they got their answers.

Second Grade Teacher A said,

> I need to do better with the structuring of my lessons. I need to complete examples, then give the students a few problems to work on while I monitor by walking around the room, and then I need to go over the correct answers on the board. After we make it through guided practice successfully, then I should assign independent practice.

Fifth Grade Teacher B made the following conclusion regarding her teaching, “I always have good intentions of trying to force my kids to dig deeper into their thinking before and during answers, but I get so rushed that I forget to focus on depth.” Closing the day, as a group, we decided to make it a goal to ask how or why every day in math, and to ask at least one student to explain how they arrived at their answer.

The next large group training and discussion took place in February of 2018. All participants were present at this training session. The two goals of this training session were to

provide a schedule for daily math station rotations and to provide examples of different types of math stations that are applicable to every grade level. Stations are good for every grade level; however, the younger students are simply not developmentally ready for self-directed learning. Therefore, their stations need to be more teacher-guided.

The training session began with a plan I designed for every class to be divided into five groups and a schedule for the groups to rotate through four stations. Below is the schedule followed by the five groups:

Group	Monday	Tuesday	Wednesday	Thursday	Friday
1	Station 1	Station 2	Station 3	Station 4	Free Choice
2	Free Choice	Station 1	Station 2	Station 3	Station 4
3	Station 4	Free Choice	Station 1	Station 2	Station 3
4	Station 3	Station 4	Free Choice	Station 1	Station 2
5	Station 2	Station 3	Station 4	Free Choice	Station 1

Figure 1. Math Station Schedule

After the design of the schedule was explained, the training session's participants and I decided on four solid ideas for math learning stations that could be adapted for every grade level. They agreed on the following student learning stations:

- Teacher guided practice at the teacher's desk
- Math game on an iPad or computer
- Independent practice (e.g. homework, worksheet, puzzle)
- Game style activity (e.g. Easter Egg Hunt, game, cards, dice, fake money)

Students in grades two through five rotated through all four stations while kindergarten and first grade students were expected to engage in the first two-teacher guided practice and the

math game on a digital device. In place of the remaining two stations, I suggested that by combining the two kindergarten and two first grade classrooms for the 45-minute math station time, this would increase the number of available teachers. I also suggested that the kindergarten and first grade teachers be creative with ideas for the independent practice-station. For example, kindergarten students could write their numbers or count items in sets (e.g., 1 to 5, 1 to 10). Their adapted list of stations could include the following:

- Station 1 with Teacher 1: Guided practice
- Station 2 with Teacher 2: Guided practice
- Station 3: Game Style Activity
- Station 4: Computer Activity/iPad
- Station 5: Independent Practice

Kindergarteners and first graders did not have a free choice day due to them not being developmentally ready for self-directed learning. However, examples of some equally effective activities for kindergarten and first grade learners are "I Spy" hunts for specific numbers around the classroom with a simple check off list for when they find the number, grouping cars into piles of three or another small number, or finger painting numbers.

Game Style Activities:

- Egg Hunt Activity Instructions – (first through fifth grade): the teacher hides 10-20 numbered plastic eggs- each with a problem inside - around the room. Students receive a paper folded long-wise with a list of numbers corresponding to the hidden eggs going down the left column. In the right column, students show their work and write their answers. This activity could focus on addition problems, subtraction problems, multiplication or division problems, fractions, unit conversions, or similar problems. To adapt this activity for kindergarteners, the teacher could instruct students to find each egg

and write down, on the paper, the number that is on the egg. This strategy may help students practice identifying numbers and writing them.

- Card Deck War Instructions – Two students each have their own deck of cards. Each flips a card at the same time and compares their cards face up. The basic level would be for just the higher number on the card to win. This level would be great for advanced kindergarten or first grade so they can practice sequencing numbers. The next level would be to see which student can answer the sum of the two face up cards first; whoever does, wins. The last level of this game would be to see which student can answer the product of the two face up cards, and whoever does wins.
- Dice War Game – Two students have two dice each. Each student rolls their dice at the same time and whatever number lands face up is their number. The same rules as the Card Deck War game apply, and the same levels can be applicable.

The focus of the guided practice station is to work in a small group with the teacher on content-level problems. The teacher focuses on why and how, and provides explanation to deepen the children's level of understanding. The teachers seemed to enjoy this training session based upon their active participation, engaged body language, and enthusiastic verbal responses. Every participant answered questions and helped to formulate stations for all grade levels. The teachers worked in pairs to help determine which math stations would work best for their grade. Everyone's body language depicted attentive participants, by leaning forward, taking notes, being quiet when needed, and conversing with colleagues when needed. I noted their focus on remaining attentive by the complete lack of cell phone use throughout the session. First Grade Teacher A said,

> This has been so helpful to have a prescribed rotating schedule for math stations. I have struggled with the best way to utilize this time and to make it the most efficient for my

> students. What I have been doing of rotating through every station in one day, has not been working.

Third Grade Teacher A responded with, "I'll be honest, I get nervous about math stations because I feel that I waste that time. Our students cannot afford for me to waste any math time."

Upon conclusion of the training session on math stations with the 20 participants, I facilitated a large group discussion for all. The participants were sitting with their partner, their colleague that teaches their same grade level. I asked everyone if math stations made them anxious. Every one of the teachers nodded their head yes. One hundred percent of the participants reported experiencing anxiety when it came to planning and facilitating math stations. I then asked if the training session on math stations was helpful. I instructed the teachers to discuss their answers with their partners and to discuss what was most helpful, if anything. I then called on a couple of pairs to report to the group if they felt the training session was helpful and what was the most helpful. The fourth-grade teachers answered first, and one reported:

> I found this training very helpful because I feel we all struggled with creating and maintaining effective math stations. Our favorite part of the training was learning different fun activities to do with our students. Sometimes we struggle to create appropriate math level exercises for our students that are fun.

The kindergarten teachers responded next with, "We are so thankful for this training because, honestly, we haven't even implemented math stations in our classrooms yet. We had no idea how to make math stations work for kindergarten, until now."

Small Group Trainings and Discussions

I conducted a small group training with the third, fourth, and fifth grade teachers in April of 2018. The training session covered how to find common factors for adding and subtracting

fractions. The topic of this training session came out of the items the teachers expressed they wanted reviewed and they suggested it was one of the most difficult concepts their students struggled to learn. The first concept I wanted to go over was how to find common factors. I wrote the following example on the board:

Ex. 2/8 + 3/16 =

I wanted to teach this problem as if it were the first time I was teaching it to my students. The participating teachers were role playing as the students, and I was role playing as the teacher. I said:

> Always ask your students to first see if the denominators are the same. If they aren't, then see if one will divide evenly into the other. Does eight go into 16 without a remainder? Yes! How many times? Sixteen divided by 8 is 2. So what you found, you must then multiply the numerator and the denominator by that number, two, in this example. 2 x 2 = 4 which is the new numerator and 2 x 8 = 16, which is the new denominator. The new first fraction is 4/16. Now we can add the two fractions because they have the same denominators. 4/16 + 3/16 = 7/16.

Most every teacher followed my explanation and agreed that is how they would work out the same problem. Several nodded their heads or answered the questions out loud.

Next, we went through another method to find common denominators that they could use to teach their students. In this method, students would multiply the two denominators together to get a new denominator that is common. For example, 2/3 + 4/5 = what? This method has to be used when one denominator is not a factor of the other. I explained:

> The first step you do is to take your two denominators and multiply them together, 3 x 5 = 15. Fifteen is your new denominator for both fractions. So now you have to figure out what your new numerators are. X/15 + y/15 = ? So ask yourself, how many times does

the old denominator of fraction one divide into 15? The old denominator of the first fraction in the problem was three, 3 times what is 15? The answer is five, so multiply your numerator from your first fraction, two, by 5. 2 x 5 = 10. Now your new first fraction is 10/15. You must repeat this step with the second fraction, 4/5. How many times does the old denominator of five divide into 15? Five times what is 15? The answer is three, so multiply your old numerator of four by 3. 4 x 3 = 12. The new second fraction is 12/15. Now you have a new problem with common denominators so you can add the two fractions together. 10/15 + 12/15 = ? When the denominators are the same, you simply add the two numerators, 10 + 12 = 22. The answer to the sum of the two fractions is 22/15. Sometimes students try to add their denominators again, so I always make them set the problem up as 10/15 + 12/15 = x/15, then they just have to finish with adding 10 + 12.

One teacher, Fifth Grade Teacher A, asked "Why haven't we had multiple lessons on fractions like this, prior to becoming teachers?" Fourth Grade Teacher A added, "No wonder my students hate and are afraid of fractions, this lesson is making me nervous." I could tell the participants' body language had drastically changed since the beginning of the lesson. They obviously weren't enjoying the lesson. Teachers quit answering questions, began checking their phones, and just overall withdrew from the training. I tried to go through the next two examples faster because they were important but it was more important that I retained the teachers' attention.

Take this problem for example, 6/20 + 3/18 = ? Multiplying these two denominators will result in a very large new denominator. But, we can simplify 6/20 because two divides into 6 and 20 evenly. Six divided by 2 is 3 and 20 divided by 2 is 10; therefore, the new first fraction is 3/10. We can simplify fraction two, 3/18, by dividing both the numerator

and the denominator by 3 because 3 divided by 3 is 1, and 18 divided by 3 is 6; therefore, the new second fraction is 1/6. We now have the new fraction problem as: 3/10 + 1/6. We can multiply these denominators together to get 10 x 6 = 60. The new denominators are x/60 + y/60, so we must determine our new numerators. How many times does 10 divide into 60? Six, so we need to multiply the numerator of three by 6 to get 18. The new first fraction is 18/60. Now onto the second fraction, how many times does six divide into 60? Ten, so we must multiply the numerator of the second fraction, one, by 10. 1 x 10 = 10. Our new second fraction is 10/60. The new problem is 18/60 + 10/60 = 28/60.

The teachers asked how I would walk through reducing that problem for my students, so I finished the problem at the board:

The fraction 28/60, can that be reduced? How do you know? The biggest give away is that they are both even numbers, so I know at least two will divide evenly into both the numerator and the denominator. However, there is a way to make sure we aren't just dividing by 2 over and over again. We need to list the factors of both the numerator and the denominator and find the largest number that is a factor for both of them:

28 = 1, 2, 4, 7, 14, 28

60 = 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60

Four is the largest factor that occurs in both the numerator and denominator. Once you find the largest factor you need to divide the numerator and the denominator both by 4. 28 divided by 4 is 8, which becomes the new numerator and 60 divided by 4 is 15 which becomes the new denominator. The reduced fraction is 8/15.

To my delight, some teachers were still following along and paying attention enough to ask for clarification. I could see that some of these teachers needed to practice fractions, but even for

educators, overcoming their predisposed fear of fractions was difficult. The teachers requested to see this again before we finished up our coaching session, so we went through a couple more problems before ending our group coaching session.

The next small group training and discussion occurred in May of 2018 and involved the fourth and fifth grade teachers. It covered how to teach equivalent fractions in multiple ways. During that visit, I held a coaching and training session with the fourth and fifth grade teachers on teaching equivalent fractions in multiple ways. The fourth and fifth grade teachers equated to four of the 18 participating teachers. All fourth and fifth grade teachers were present at the coaching session. I had asked each teacher to bring an empty pizza box with them. I requested one teacher to draw a pizza in her empty pizza box with half cheese and half pepperoni and cheese. I then requested the second teacher to draw a pizza in her empty pizza box with 2/4 banana peppers and 2/4 pepperoni. I requested the third teacher to draw a pizza in her empty box that represented 4/8 sausage and 4/8 pineapple, and I requested the last teacher to draw a picture of a pizza in her empty pizza box that depicted 8/16 pepperoni and 8/16 mushrooms. The idea behind the pictures of pizzas in an empty pizza box is to give students a visual representation of four different but equivalent fractions. The pizza boxes also relate fractions to something all children have seen and show a real-world application of fractions.

The teachers were really involved in this activity. Their body language showed excitement and was almost kid-like. This training received the best response from the teachers. We were discussing fractions but I did not observe any anxiety from the teachers in the beginning of the training. The teachers stayed attentive throughout the activity. After the teachers created the pizza boxes, I explained how easy it would be to make it a project for students to take home and then come back to school to find their equivalent fraction in the room. Simply give each student a specific pizza to draw in his or her pizza box to ensure everyone has

a partner with an equivalent fraction represented by his or her pizza. I then showed the teachers how to find equivalent fractions mathematically on paper:

> In the problem, 2/4 = x/8 our job is to find a value to replace x with that still solves this statement. The second fraction still has to be equivalent to the first. So, 4 times what is 8? Two, yes! Now you take your numerator of the first fraction and multiply it by 2 to get the numerator of the second fraction, 2 times 2 is 4. The answer to x is 4, and equivalent fraction to 2/4 is 4/8. Another way we can solve this same problem is by cross-multiplying. You multiply your first numerator to your second denominator, 2 x 8 = 16, then you take your product of 16 and divide it by the number left, 4. 16/4 = 4. The answer still worked out to be four.

I could tell the teachers did not use cross-multiplying to find equivalent fractions because their body language instantly changed, as did their demeanor. Fifth Grade Teacher B said, "I don't teach that method. Should I? Do you think it's easier for the students to grasp?" Fourth Grade Teacher B responded with, "Yeah I like that method. Can you show me some more examples?" I was surprised that none of the teachers taught their students the method of cross-multiplying to find equivalent fractions, because it is very easy to do for every type of equivalent fraction problem. It is also less complicated for students who do not know their multiplication facts well enough to find factors quickly. Once I realized that the teachers wanted more practice on finding equivalent fractions by cross-multiplying, I set up more such problems for them to do. After practicing the problems and going around to each teacher, I was able to see when they felt comfortable doing the cross-multiplying method. The teachers told me they liked the cross-multiplying method so much more than ways they had previously taught this concept and they felt like it was easier. The end of the training session focused on the benefits of finding new ways to solve problems.

Observations/One-on-One Coaching

The first observation and coaching session I had one-on-one with a teacher was with Second Grade Teacher A, a long-term substitute. The 2017-2018 school year is Second Grade Teacher A's first full teaching position. She is a recent college graduate with a degree in elementary education. During her time at university, Second Grade Teacher A took college algebra as her one math content class and took two math methods classes. In our initial discussion I asked Second Grade Teacher A how she felt about math and teaching math. She replied, "I love math, and I love when students get excited about math. But it's hard to teach kids who don't." Another question I asked Second Grade Teacher A in our discussion was, "What is one of your biggest challenges in teaching math to your students?" She replied, "No connections were made between concepts or grade levels."

After our short discussion, I co-taught a lesson on money by being in charge of one of the math stations in her classroom. Second Grade Teacher A had emailed me the previous week and requested I come by her room to help her to run smooth and efficient math stations. She had her students broken into four groups for the corresponding math stations; I had a station with play money and task cards with questions related to money on them for the students to answer. There was also a computer station where students worked independently on Math IXL (a self-paced computer program for math) and a station with addition and subtraction flash cards that students could use to pair up and quiz each other. In the fourth station, Second Grade Teacher A had students work on a textbook page while she guided them through the problems.

I also gave Second Grade Teacher A the suggestion to not rotate math stations four times in 45 minutes, every day. The students just spent most of the time shuffling from station to station, getting settled, cleaning up, and shuffling again. The students were losing a lot of valuable class time shuffling between stations. I suggested Second Grade Teacher A set up her

math stations to rotate every day, rather than every 45 minutes and to have a simple poster on the board for the students to follow. An example of the suggested math station rotation schedule is shown in Figure 2.

Group	Monday	Tuesday	Wednesday	Thursday	Friday
1	Station 1	Station 2	Station 3	Station 4	Free Choice
2	Free Choice	Station 1	Station 2	Station 3	Station 4
3	Station 4	Free Choice	Station 1	Station 2	Station 3
4	Station 3	Station 4	Free Choice	Station 1	Station 2
5	Station 2	Station 3	Station 4	Free Choice	Station 1

Figure 2. Math Station Weekly Rotation Schedule

I told Second Grade Teacher A she could label the stations as she wished, and to assign each group a number so they could easily follow the schedule. She was thankful for the suggestion because she said she knew her current method was not efficient. "I knew my students were spending too much time moving from station to station, but I had only seen math stations rotate through every station in one day."

In March of 2018, I went back to observe Second Grade Teacher A upon her request; she really wanted extra support. I observed a significant improvement in her math stations, as well as in her questioning technique during her lesson. This improvement was a direct result from implementing the daily rotating math stations schedule and Second Grade Teacher A's increasing confidence. Second Grade Teacher A was clearly confident about the design and efficacy of her four different math stations, and about her classroom running efficiently. The four stations she used during this observation were students completing a worksheet on money problems at a place of their choice (rug, rocking chair, table, or desk), a computer station where the student worked on the Math IXL software, Second Grade Teacher A's station for guided

practice on place value and breaking apart tens and ones, and the last station was the Egg Hunt Activity. It was evident the students loved the Egg Hunt Activity. When the students looked at the schedule of rotations for math stations and realized it was their day to do the Egg Hunt Activity, they jumped in excitement. I asked Second Grade Teacher A what she did for the fifth day of rotation, and she said we usually do Fun Friday and play a math game as a class. I had a clear picture of how she was utilizing her math instructional time.

Upon completion of my observation with Second Grade Teacher A, I decided to observe other teachers. That particular school day was a little different due to it being the day before spring break with half of the grades preparing for an egg hunt in the evening and the other half participating in the literature fair. However, in most of the classrooms I walked into, students were working and teachers were teaching. I did walk into one room, Fifth Grade Teacher A's classroom, where the students were having a cleaning party during what was supposed to be math time. This was disappointing but I just quickly turned and walked back out, remembering the complexities of that specific day. Later, Fifth Grade Teacher A approached me and apologized that I didn't get to observe her class working on math. She said, "I simply had half of my class at the literature fair, and I didn't want to move on and cause anyone to become behind." I told her she didn't need to apologize; that I was not there to judge. I suggested she could have maybe handled the situation differently, and I would be happy to offer some advice if she wanted it. Fifth Grade Teacher A quickly said, "Yes! Of course!" I advised her she could have utilized the time to pull out those students that were struggling with the newest concept or those that are simply behind. It would be an excellent time to work more one-on-one with those that need it. We spoke about the students that could have played a math game on multiplication and division facts since students always need extra help on those topics. Fifth Grade Teacher A seemed very receptive to the suggestions. Fifth Grade Teacher A was open to taking my suggestions and

utilizing them in her classroom. Fifth Grade Teacher A said, "It is so helpful for a certified math teacher to provide feedback on what I can do to help my students better grasp their math content."

Next, I went to visit an experienced fourth grade teacher, Fourth Grade Teacher B. As I observed Fourth Grade Teacher B, I could immediately see the stark contrast between her, Second Grade Teacher A, and Fifth Grade Teacher A. Fourth Grade Teacher B felt comfortable in her room, as she was clearly relaxed, and my presence didn't affect her teaching. Fourth Grade Teacher B's students also seemed very relaxed but attentive, and they gave chorus responses to her questions. Fourth Grade Teacher B's students would raise their hands when questions were not meant for a full class response, and Fourth Grade Teacher B would confidently call on them by name. When a student would answer a question, Fourth Grade Teacher B would ask the deeper thinking level questions, such as how did you get your answer, and can you explain why you chose to do it that way?

Fourth Grade Teacher B picked a problem from the student problems and completed it under the document camera so all of the students could follow along with her every step. After she finished the problem, she asked the entire class, "Did you do it that way? If not, how did you do it?" She then called on each student who had their hand up and asked them to explain how they solved the problem differently. This was a great method of teaching students multiple ways to complete problems and reducing their anxiety on completing a problem the "wrong" way. I also valued the classroom routines Fourth Grade Teacher B clearly had established. Her students knew when to answer out loud and when to raise their hand. The students paid attention to her explanations, and when they had completed a problem but were waiting on the class to finish, they quietly read a personal book at their desk. Fourth Grade Teacher B confidently walked around the room checking student progress and would urge them to check their answers if

needed. This is the type of classroom all teachers aspire to have. With coaching and extra support, new teachers can get to this level faster.

After I completed one of my visits, I stopped by to see the principal, Ms. R, who spoke to me candidly about her concerns moving forward to the end of the year. She wanted to make sure her teachers were focusing on big connections, hands-on activities, math stations, and learning new material while still reviewing old material. Ms. R wanted me to continue to work closely with Second Grade Teacher A, a long-term substitute in one of the second-grade classrooms. Ms. R also wanted me to work with the fourth and fifth grade teachers on math content and different ways the teachers can teach the content to ensure every student can learn all math concepts. This was a topic the teachers themselves had requested at the initial meeting for the coaching and mentoring program.

Co-Teaching

Every participant had the chance to invite me into their classroom to co-teach a class. Only one teacher decided to take advantage of this opportunity. Having a certified math teacher (myself) freely available could have helped to increase teacher confidence and student understanding and decrease math anxiety found in the classroom from both the teachers and the students. I had a co-teaching session with Fifth Grade Teacher B. Fifth Grade Teacher B had only been teaching for two years. She asked me to help her come up with a good lesson that was hands-on, about 45 minutes long, interactive, and covered all units of measurement. We created 20 task cards that had different conversion problems from how many ounces are in a cup to how many are in two gallons, as well as conversions in yards, feet, meters, grams, pounds, kilograms, etc. The students received one paper with 20 boxes to record their answers and show their work for their 20 problems they would find as they moved from group to group. The 20 task cards

were set up to have five tasks at each group. The students had ten minutes at each group before they rotated.

Before we started I asked Fifth Grade Teacher B how she was teaching her students to convert between units of measurement. I did not want to confuse the students or teach it in a way that may be too complicated for their current level. She said that she had her students working their way up through the conversions. They started at the bottom and converted up in steps. For example, if the students needed to covert 22 ounces to quarts, Fifth Grade Teacher B had her students determine how many cups are in 22 ounces, then how many pints, then how many quarts. I asked Fifth Grade Teacher B if she had taught the students how to complete ratios. She said, "No," and seemed to get anxious when I mentioned it; she became even more so when I showed her how to complete the same problem using ratios. She admitted she didn't know how to do it that way. The problem would have been much shorter, quicker, and easier if we could complete it using ratios, but I did not want to make her uncomfortable or her students uncomfortable so we decided to proceed with the lesson in the way she had been teaching the students. Fifth Grade Teacher B displayed the units up on the board at the front of the room and I added in a few that were in the assignment but not on the board.

The lesson started out with the students watching me go through a couple of similar problems to ones on their task cards while they orally guided me on what to do, how to do it, and why I should do it. The students were very responsive and active in answering. They seemed knowledgeable and eager to start the activity. As the students worked the first ten minutes on their first set of task cards, in their first group, I walked around to each group to make sure they were doing well and staying on track. Fifth Grade Teacher B did as well. A couple of students were slow to start and she observed them closely as they often struggled to say on task. Fifth Grade Teacher B guided and redirected these students as needed.

The students progressed but I noticed they did struggle when the problem required them to work their way up the conversion list with more than two steps. This is where the ratio set up for conversions could have helped. Once the students moved to their next group, they kept working and seemed to feel more comfortable completing the problems and asking for help when needed. By the end of rotations, we gathered the attention of the students to the board and completed one of the most challenging problems. Overall, the lesson was successful. Fifth Grade Teacher B effectively taught units and conversions prior to this activity. She asked relevant questions and engaged all of her students to answer, participate, and understand. This lesson may have been more productive if the teacher felt more comfortable solving ratios and teaching them to her students. She could have reduced the number of steps students had to take to solve the problems, thus reducing the number of mistakes students could have made and reducing the amount of time spent on one problem. The students who were struggling often did so because they got lost in too many steps to follow and keep track of. The ratio set up to solve unit conversions could have helped.

After the lesson, Fifth Grade Teacher B asked that I teach her how to set up unit conversions to be solved with ratios and how she could best teach her students the process. We discussed that all students can learn both ways to solve the problems and then choose which way they prefer. Fifth Grade Teacher B decided she would try to introduce it the next day during class and see how the students respond. During the co-teaching session, I took detailed field notes on how Fifth Grade Teacher B interacted with her students, and how her students interacted with her. I observed how familiar her students were with Fifth Grade Teacher B walking around and asking students probing questions to fix mistakes. In my field notes, I detailed the apparent knowledge her students had practice on moving stations and working their way through difficult problems. Fifth Grade Teacher B's students moved fluently from one

station to the next and never asked Fifth Grade Teacher B for the final answer; they only asked for guidance on what step to do next. I explained all of the great things I saw while observing and co-teaching with her: the students knew their units of measurement, they knew the appropriate conversions, they participated well throughout the lesson, they changed groups well, she stayed with the students that were less motivated or struggled and encouraged them throughout the lesson, and she did not give answers to students, she only guided students by asking prodding questions.

Fifth Grade Teacher B told me some of her concerns that she felt affected her overall efficacy as a fifth grade teacher. She was concerned that it was only her second year teaching: "My lack of experience definitely affects my confidence in the classroom." Fifth Grade Teacher B was also concerned about teaching some of the fifth grade math concepts because she did not feel she had learned enough math content in college. She also felt that she did not know enough different ways to teach some of the math content to ensure all of her students could adequately grasp the concept. The last thing that Fifth Grade Teacher B expressed her concern about was the insufficient levels of mathematical knowledge her students often brought with them to fifth grade. Fifth Grade Teacher B felt that students were already severely behind upon entering fifth grade, which made it even more difficult to teach fifth grade math content. Her concerns are the same concerns and challenges that many elementary educators have.

Interviews

The interviews were conducted at the end of the professional development program, in May of 2018. The four volunteer interviewees were Kindergarten Teacher A, Kindergarten Teacher B, Third Grade Teacher A, and Fourth Grade Teacher A. The four interviewees were only required to take college algebra as their highest math content course in college, along with two math method courses. The interviewees described their math experiences and math learning

as frustrating, lacking, and just not enough. One teacher even said he struggled teaching fractions due to his own fourth and fifth grade teachers not teaching fractions to him. Every teacher interviewed felt they did not receive enough math content in college to be prepared to teach math to their students. The following themes arose during the interviews: favorite subjects to teach, not prepared, math anxiety, and mentoring and coaching.

Favorite Subjects to Teach

When the interviewees were asked what their favorite subject to teach was, half of them stated math. When Kindergarten Teacher A was asked about his favorite subject to teach, he replied, "I really have enjoyed teaching reading because I feel like I'm better prepared for that." Third Grade Teacher A also had a revealing answer to the question regarding her favorite subject to teach. "I started to enjoy math over the years as I have developed new methods for successfully teaching the students." Third Grade Teacher A's answer gives insight that after she became more prepared to teach math, with new methods to be successful, she enjoyed teaching it more. Another interviewee, Fourth Grade Teacher A, stated since she had the most experience in fourth grade math, it was her favorite.

Kindergarten Teacher A was asked specifically if he enjoyed teaching math, and he gave a very detailed and honest answer.

> I enjoy teaching kindergarten math a lot more than I did teaching fifth grade math. Fifth grade math was not enjoyable at all. In fifth grade, when we first start, you've got kids that don't know anything. Then you got kids that know everything they should know when they come to fifth grade. So there's a lot of intervention involved there.

Third Grade Teacher A also gave a very detailed answer as to whether she enjoys teaching math and why:

> I was lucky when I started teaching to work with a math teacher who offered a plethora of knowledge on the building of math concepts and different ways to teach. I feel that this has helped me to enjoy teaching math over the years. I feel that as time passed I have been able to work out a map of review, introducing, and re-teaching concepts in various ways in order to reach all of the students I teach.

Not Prepared

"Do you feel you received enough math content in college to be prepared to teach mathematics in grades K-6?" I asked each interviewee this exact question during our interview. Every single one replied "No!" Fourth Grade Teacher A actually sounded disappointed and even angry as she responded:

> Absolutely not! College didn't go over a lot of methods of how to do things, because it had been years since I had done that type of math. Even though I knew how to do it, but actually trying to teach kids how to do it, that was the hard part. The classes I had, and the professors I had, never really went over that kind of stuff. They would show us hands-on activities and stuff we could do with them, but as far as actually teaching them, they didn't go over any of that. So no, I don't feel it prepared me at all!

Kindergarten Teacher A and Kindergarten Teacher B commented on the question as well. They felt that if teachers 'get math' then they would feel fine in the classroom, but if they struggled with math, the teachers were going to continue to struggle while teaching math. Kindergarten Teacher A even described his feelings regarding only having to take college algebra in college and the fact that if the student barely passes it with a 'C' then they have still finished their math content requirements for an elementary education degree. "A 'C,' that's not showing that you mastered the skill. That's showing you're average. You shouldn't be teaching children. They do prepare you for primary teaching of math, but third, fourth, and fifth grade, especially fourth

and fifth grade, there's no preparation!" All four interviewees felt that the math content they received in college was not enough to adequately prepare them to teach third, fourth, and fifth grade.

Two of the interviewees also emphasized the importance of having an experienced teacher to teach pre-service teachers how to be a teacher. An experienced teacher would understand the importance of teaching content in multiple ways. The interviewees had several suggestions to increase the level of preparation that teachers will experience. They suggested colleges require teacher candidates to take math courses on fractions, money, factoring, and units of measurement. The interviewees suggested the courses be half content and half methods to teach the content. The interview participants also suggested that to become elementary teachers they should be required to take and pass an elementary certification exam.

Math Anxiety

The next part of the interviews addressed math anxiety. Do teachers experience math anxiety? Do their students experience math anxiety? What are some indicators that a student is experiencing math anxiety? And, if they felt that a teacher's math anxiety negatively affects their students? Every interviewee felt that some students experience math anxiety; one teacher, Fourth Grade Teacher A, even stated that approximately half of her class felt some level of anxiety about math. Every teacher also agreed that the math anxiety hinders the students' learning by slowing it down. Some of the indicators of math anxiety that these teachers cited include the look of concern on their (students') faces, the "deer in headlights look"; the amount of questions they ask; the type of questions they ask because the students do not know enough to be specific; and students who simply shut down and refuse to work or participate.

Another common factor the teachers discussed when answering questions about math anxiety were the students' parents' perceptions of math. Third Grade Teacher A stated, "There

are students who are anxious about math, and I feel it often comes in students who are already behind. I also often find times that their parents hate math and perhaps share that feeling with their child, adding to their feelings of anxiety." Kindergarten Teacher B also had a similar answer that commented on parent math anxiety being a part of the problem when Kindergarten Teacher B was asked, "Do you find students are afraid or anxious about math?" She replied with, "One hundred percent! Math is another language. It has its own set of symbols and shapes. But you have parents at home saying, 'Math is a horrible, awful, terrible thing' and that starts the math anxiety before the children even step foot in a classroom." Kindergarten Teacher A and Kindergarten Teacher B both agreed that kindergarteners come into school being anxious about math. Kindergarten Teacher B went on to describe an unexpected effect of student math anxiety is its effects on the teacher. When a student experiences math anxiety it slows down their learning, and forces the teacher to find another way to teach the problem to students. This can cause the teacher to experience anxiety about his or her own abilities. Fourth Grade Teacher A mentioned exactly this idea, "When a student experiences math anxiety, it makes me nervous. Am I going to be able to show them another way to do it? Will they not be able to understand the concept because of me? It makes me very nervous."

The interviewees were asked if they experienced anxiety about math or teaching math. Most said they do not experience math anxiety regularly but they definitely had triggers that could produce math anxiety for them. The experienced teacher, Third Grade Teacher A, stated she had a math teacher as a mentor when she first began teaching so due to experience, support, and adequate preparation she did not become anxious when teaching math. Third Grade Teacher A pointed out the importance of being prepared in order to reduce math anxiety. Fourth Grade Teacher A talked about what can trigger her own math anxiety in the classroom: "The only time I get really nervous is whenever we hit division and fractions, because those are two complicated

concepts that are really hard for kids to understand." Fourth Grade Teacher A is still concerned and not confident with her abilities to teach fractions to every one of her students, through different methods. She said the training sessions we completed on fractions really helped her to solidify her knowledge and to provide her with a couple of new methods she could utilize to be more efficient at teaching fractions. However, Fourth Grade Teacher A said she would benefit from a certified math teacher being easily accessible to her when she needs advice or help with a student not understanding a concept. Kindergarten Teacher A also stated that his trigger for math anxiety is fractions, only he feels it is because his elementary fourth and fifth grade teachers did not teach them at all: "I got no fraction instruction until I went to college, and that was minimal and only one way to do it. I need to know multiple ways!"

The last big question the interviews covered on math anxiety was, "Do you feel that a teacher's math anxiety affects their students?" Again, all four interviewees unanimously agreed, that a teacher's anxiety affects her students. They cited reasons such as if a teacher does not understand a concept, they cannot teach it or answer questions to the extent they need to, therefore causing the students to fall further behind. If students see their teacher is nervous about the concept, they will pick up on it and become nervous themselves.

Mentoring and Coaching

The last theme in the interviews involved mentoring and coaching. The entire study stemmed off the coaching and mentoring professional development program. All four interviewees believed coaches, or mentors, are helpful, needed, and beneficial in increasing student achievement and teacher efficacy. Third Grade Teacher A stated, "I feel having more than one person explain a concept is nothing but beneficial to the students." Kindergarten Teacher A said, "When I was teaching fifth grade, I'm confident I wouldn't have made it without

our coach!" The other interviewees stated the importance of extra support. However, all of the interviewees also had some specifics about coaching that they felt helped the most.

The second thing the teachers requested from an academic coach is for one to be in their building at all times. "We need coaches in the building to help us. A teacher in the building whose job is to help other teachers," stated Kindergarten Teacher A. The last major suggestion from the participating teachers was to have the academic coach be subject based. An academic math coach, like the coaching and mentoring program they have been a part of, would be the best option to help with any teaching deficiency in mathematics. "I think mentoring and coaching is better subject based. If you are having trouble teaching math, it's better to have someone that can focus on just that. You need someone that specializes in math to help you!" explained Fourth Grade Teacher A.

Each interview participant was asked how he or she felt about the coaching and mentoring professional development program. The teachers were asked to be candid and to explain what parts of the coaching program were the most helpful, and what parts could have been more helpful. Every teacher mentioned they loved having a certified math teacher show them how to do different math content in multiple ways, and how to take different math strategies, such as math stations, and apply them to their grade level. Third Grade Teacher A put it this way:

> As I said before, anytime you can have another teacher to explain concepts is always helpful. In this situation it was more helpful because the other teacher was a certified math teacher, so being able to have that depth of knowledge readily available was awesome! It really reduced my own anxiety when it came to worrying if my students would understand a concept.

Fourth Grade Teacher A added her favorite part of the coaching program was the extra content support provided:

> I loved having you teach me different ways to find equivalent fractions and then teaching me how to apply it. I also loved the support I have received while actually teaching it in the classroom by having a certified math teacher there to guide me and to assure I could answer any and all questions my students may ask, in depth.

Kindergarten Teacher A also shared how much it helped to have someone show every teacher how to apply the math stations to their grade level and how to implement them.

Final Meeting

The coaching and mentoring professional development program finished at the conclusion of the school year in June. The full group of participating teachers and teachers' aides met for their end of the year faculty senate meeting. After that meeting, the full group of 20 participants and myself had a group discussion regarding their perspectives on math and math learning, their confidence in teaching and overall efficacy as a teacher, as well as the coaching program itself. I opened the discussion by asking for individuals to share their current perspective on mathematics and teaching mathematics and to reflect on any changes that occurred over the course of the professional development coaching and mentoring program. I gave the group a couple of minutes to discuss their answers with someone near to them, and then asked for volunteers to share their answers. I took detailed notes while they were responding including direct quotes. After the discussion, I went through my notes to provide more details.

When I asked if anyone would like to share their current perspective on math and teaching mathematics, Fourth Grade Teacher A raised her hand:

> I went through elementary, middle, and high school dreading math class. When I went to college I continued to dread math class. I barely made it through college algebra, but I

> felt relieved because I knew math was over. I forgot I will be responsible to teach math to elementary students my entire career. My negative attitude and anxiety prevented me from learning math in depth and at the level I really needed to be in order to teach math.

I asked the fourth-grade teacher if she felt that her perceptions of math had changed any since the beginning of the professional development program. She responded with, "Yes! I think I learned that I'm not the only teacher that could benefit from reviewing our math content." Another teacher raised her hand to answer the question, Fifth Grade Teacher A:

> I use to look at math class time and math stations as, let's just get through it. I now find myself excited to try to reach every child in my class during math time. I challenge myself to ensure that every student has a basic understanding of the math concept we are learning.

The next topic we discussed, first in partners and then in the whole group, was whether the teachers' confidence in teaching math had changed throughout the professional development program. One pair of teachers, third grade teachers, were in a long discussion regarding this topic. As I walked around the room, I heard Third Grade Teacher B say, "I feel more confident because I have more methods to teach the same content when a child gets stuck." After the teachers discussed this topic in pairs, I asked if that same third grade teacher would share her response I overheard while walking around. One of the teachers told the group of participants how she became more confident teaching math to her students because she developed a larger repertoire of methods to use. Several agreed by nodding their heads and verbally saying they too liked that they received training on how to teach fractions using different methods. Fourth Grade Teacher B said, "So many of my students don't grasp how to add and subtract fractions the first way I teach it, but I honestly didn't know another way to teach it. Now I can say I do!" Second Grade Teacher A, that I directly helped with her math stations said,

> I felt more confident implementing and facilitating math stations the very next day after your suggestions. My confidence really helped my students as well. They knew I was confident and that I was taking our math instructional time seriously. Therefore, they began to take it more seriously.

When the topic of math anxiety came up, I could see the teachers were still a little reluctant to admit they experienced or felt math anxiety. I asked the group if they felt they had math anxiety at any time during the professional development program. Did they experience it prior to the program, during a training in the program, or do they still have some math anxiety? One teacher, a kindergarten teacher, that was a fifth grade teacher the prior year, raised his hand:

> I'll be honest; I have been afraid of math since fourth grade when my teacher introduced fractions to me. Last year, I found my anxiety creeping back up because I did not feel like I was prepared to teach the math content.

He went on to say that he saw math anxiety in his kindergarten students. He felt the best way to address math anxiety is to practice, practice, and practice. A first grade teacher commented and added to the kindergarten teacher's statement that children who are introduced to concepts and helped to make a connection to previous learned content, show less anxiety when it comes to learning new math content.

I asked if any teacher felt that their math anxiety had decreased throughout the course of the professional development coaching and mentoring program. One fourth grade teacher said she used to feel anxious about her ability to successfully teach her students how to find equivalent fractions. However, her anxiety had significantly lessened because she was made to practice it more herself and was able to provide multiple ways for her students to complete the content. Multiple teachers came to the consensus that their math anxiety seemed to be triggered

by fractions, and that it was reduced as a result of the trainings provided on fractions and the extra practice the trainings provided the teachers.

The last topic we discussed was if the professional development program helped the participating teachers' mathematics teaching efficacy and if it did, what part of the program helped and how did it improve their mathematics teaching efficacy. The teachers seemed to discuss this topic for several minutes before settling down. The teachers were asked for volunteers to share their answers. Fifth Grade Teacher B shared her answer first:

> I felt it was really helpful to practice math content that students struggle with learning. It helped to refresh myself before I taught it to my students. It was also beneficial to learn different hands on activities we could do. I had my students complete the pizza box activity and they loved it. I felt it really helped them to make a connection of fractions to everyday life.

Another teacher stated that it was really a confidence booster to just have a certified math teacher observe her class, and then give positive feedback that she was being an effective mathematics teacher. One of the kindergarten teachers spoke of the math stations training and how beneficial it was. Kindergarten Teacher B stated, "Our county implemented math stations for every grade but did not offer a training that showed its applicability in kindergarten. I needed your training so I could implement it in my classroom."

The group discussion then moved to generate suggestions to improve the professional development program if it was duplicated at another elementary school. Several teachers suggested that the professional development program simply continued, but reduced to only monthly trainings. The teachers stated they liked the small group and large group trainings because they helped to keep the trainings relevant to those involved. Only teachers that taught fractions were required to attend the training on fractions. A third grade teacher suggested each

school keep a certified math teacher to co-teach lessons in the third, fourth, and fifth grade classrooms. Lastly, a fifth grade teacher suggested the professional development program offer a math course on fractions and teaching fractions to ensure teachers are prepared to teach the concept to their students.

CHAPTER 5: INTERPRETATIONS

Introduction

The purpose of this study was to answer the three research questions:

- Question 1: How do participating elementary teachers describe their experiences with mathematics and teaching mathematics?
- Question 2: How do the participating elementary teachers describe their level of mathematics anxiety?
- Question 3: To what extent can a tailored and differentiated mentoring and coaching program affect participating teachers' mathematics teaching efficacy?

This chapter is organized by research questions. Under each research question I have organized my interpretations based on the parts of the study that addressed that particular question. For example, interpretations for Research Question 1 are broken into math content, group training sessions, underprepared, and coaching. Every piece of this study—the initial meeting, the Initial Open-Ended Survey, group training sessions, group discussions, observations, and interviews—in some way touched upon how this particular unique group of participating teachers experienced math and teaching math, how much math anxiety the teachers experienced, and how this particular mentoring and coaching program helped them to increase their overall sense of mathematics teaching efficacy.

Research Question 1: How Do Participating Elementary Teachers Describe Their Experience with Mathematics Teaching and Learning?

At the outset of this study, participating elementary teachers described their experiences with mathematics and teaching mathematics in mostly negative terms. In group discussions, coaching sessions, observations, co-teaching sessions, and interviews, the participating teachers made multiple comments that described a previously learned and deeply held anxiety towards

mathematics and a lack of mathematics content knowledge, both of which worked against their abilities to be successful in their classrooms. At the very first meeting, the participating teachers expressed concern about not knowing multiple ways to teach their math content and not feeling prepared to teach math to their students. In very general terms, participating elementary teachers described their experiences with mathematics teaching and learning in ways that referenced a lack of mathematics content knowledge, anxiety over having that lack "found out," feelings of being unprepared to teach mathematics, fear of mathematics itself, and worrying that their mathematics deficiencies would become their students' deficiencies.

Initial Meeting

In the initial meeting, the participating teachers stated how they wished they could have taken more specific math content in college, such as a course on all things fractions. One teacher even concluded himself that he needed to be a master at fractions before he could teach his students how to be masters at fractions. The initial meeting with the participating teachers gave a clear picture of teachers that felt underprepared to teach their math content. Only 25% of the participants said they felt prepared to teach the math content in their grade. Training relating to standards around fractions was a common request. Fractions became a common theme throughout the professional development coaching and mentoring program as they seemed to trigger math anxiety in the teachers and required more support to teach to the students. The initial meeting revealed that the participating teachers wanted extra training and support for several concepts, including math stations, fractions, units of measurement, multiplication facts, factors, and money.

Upon analyzing and interpreting the participants' responses on the Initial Open-Ended Survey, I was able to conclude that the participating teachers understood the importance of learning mathematics in elementary school. Students today will face new demands for

mathematical proficiency and will learn that mathematics is no longer restricted to a select few (Kilpatrick et al. 2001). Again, "All students need to be able to think mathematically, and they must think mathematically to learn" (Kilpatrick et al. 2001, p. 1). The participating teachers knew it was important to be able to teach math content in several ways, but most of them seemed to struggle with doing so. The teachers requested help with this in the form of group training sessions.

The participating teachers described their previous experience with mathematics learning in mostly negative terms. They described learning instances throughout their educational processes where the mathematics teacher disliked math, spent less time on math during class time, and was not confident in delivering math lessons. They also described embarrassing situations with peers when answering math problems incorrectly. Fourth Grade Teacher A said,

> I remember my own fourth grade teacher deciding to skip math classroom time to focus on reading. At the time it didn't bother me, but now I look back and remember that as a regular occurrence that definitely negatively affected my mathematics learning.

Multiple participating teachers spoke of similar instances where their elementary teachers took the focus off mathematics and placed it on another subject, such as reading.

The participating teachers described similar situations they found themselves in while teaching mathematics to their students. One fifth grade teacher spoke of how she found herself becoming irritated more easily during math lessons than reading, science, or social studies lessons. Another participating teacher described how anytime her class got interrupted and she needed to shorten a lesson, math seemed to get shortened more often than the others. Both of these teachers felt that these were just unconscious decisions they have made. Perhaps, these teachers are unconsciously following the footsteps of their predecessors by placing less importance on math lessons.

Group Training Sessions and Discussions

I was able to conclude more about the teachers' perceptions regarding math and teaching math from the large and small group trainings and discussions. The participants had a collective feeling of being underprepared to teach their math content. In every group meeting, the fact that a teacher did not feel prepared became evident. Teachers made statements such as, "I can't do fractions, because I was never taught how to by my own fourth and fifth grade teachers." Fifth Grade Teacher B stated, "I get nervous when a student questions my answer because I immediately think, did I do it wrong." When I began this study I was curious about whether teachers believed the math content knowledge they gained in college as part of their teacher education curriculum was enough for them to develop the mathematical sense and knowledge necessary to teach elementary mathematics. I was not surprised when meeting after meeting, and conversation after conversation, guided me to the conclusion that, generally speaking, teachers did not obtain enough math content knowledge to develop the mathematical sense to teach mathematics to elementary students. Hiebert et al. (1997) suggest in *Making Sense*, that teachers must learn to make sense of mathematics. Teachers must move themselves to higher order thinking, generalizations, and rigor that were probably not present in their own mathematics education if they are to effectively teach even the most basic mathematical concepts to their students.

The participants described their own mathematics teaching as mostly trying to "just get through it." They knew the basics and the basic way to teach the math content, but they struggled with creating new methods of teaching old concepts. They struggled with reaching every child in their classroom. Fifth Grade Teacher A stated, "I can teach fractions but I honestly don't know how to teach adding and subtracting fractions in four different ways, and sometimes I feel like if I did know how to do that, I would be able to help more of my kids." In

the initial meeting with the participating teachers, it was a common theme that the teachers felt they needed to know more ways to teach their math content.

Interviews

Interviews with the four volunteer participants demonstrated they all felt they did not receive enough math content in college to be adequately prepared to teach elementary mathematics. All four interviewees expressed similar concerns about the low mathematics content knowledge requirements to become a teacher and the lack of targeted mathematics support and training they receive once they become teachers. Each of the interviewees had been required to take only one content course in mathematics to obtain their bachelor's degree in elementary education, kindergarten through sixth grade. When answering the initial interview question regarding whether they felt prepared to teach mathematics to their students, some of the interviewees even sounded angry in their responses. Fourth Grade Teacher A expressed her disappointment that her college courses did not teach a lot of different methods to deliver content. She also felt her classes should have taught the content prior to simply teaching activities to do with students on the math content. Ford & Strawhecker (2011) concluded that it is critical that elementary teachers have a deep understanding of the connections between math content and math methods in the elementary classroom. Fourth Grade Teacher A said it had been years since she did some of the math they are required to teach and she really needed to review it to ensure she knew it well enough to teach it to her students.

When the interviewees were asked what their favorite subject to teach was, half of them stated math but their follow up answers as to why math was their favorite subject to teach tells a lot more about their love for teaching. Fifth Grade Teacher A enjoyed teaching reading because she felt like she was more prepared to teach reading and thus better at teaching reading. A previous fifth grade teacher, Kindergarten Teacher A said, "I really have enjoyed teaching

reading because I feel like I am better prepared for that." His reply immediately suggests he enjoys teaching reading because he felt more prepared to teach it, concluding that he does not enjoy teaching math as much because he feels less prepared to teach math. During the interviews, Third Grade Teacher A stated that her favorite subject to teach is math. She also elaborated on why she enjoys teaching math. Third Grade Teacher A likes how she has developed new methods to successfully teach math to her students and how, through experience, she has become a better math teacher. Her elaboration on her fondness of teaching math suggests that she did not feel prepared to teach math upon graduating college with an elementary education degree, but after experience and mentoring she did. Another interviewee, Fourth Grade Teacher A, also described her favorite subject to teach as math, but only after she had acquired experience in teaching mathematics.

When Kindergarten Teacher A was asked if he enjoyed teaching math, he honestly responded with how he enjoyed teaching kindergarten math a lot more than he did teaching fifth grade math. He went into detail as to how much more complicated it is to differentiate the fifth grade math lessons to accommodate the varying levels of math knowledge fifth graders may have. Kindergarten Teacher A's answer only touched on how difficult it can be to teach math to fourth or fifth grade students. Even if you are an experienced teacher with a strong math content background, it can be difficult due to students' varying math content levels.

Third Grade Teacher A gave another great answer as to whether or not she enjoys teaching math and why:

> I was lucky when I started teaching to work with a math teacher who offered a plethora of knowledge on the building of math concepts and different ways to teach. I feel that this has helped me to enjoy teaching math over the years. I feel that as time passed I have

been able to work out a map of review, introducing, and re-teaching concepts in various ways, in order to reach all of the students I teach.

Third Grade Teacher A provided evidence that a new teacher paired with an experienced teacher as a mentor can help to alleviate the stress of being a new teacher and to increase the new teacher's confidence and efficacy. The fact that Third Grade Teacher A had a math teacher as her unofficial mentor when she was a new teacher really helped to strengthen her skills as a math teacher. Having a math teacher as a mentor is a unique situation, and Third Grade Teacher A obviously benefited tremendously from the mentor/mentee relationship, as did her students as a result. Third Grade Teacher A's positive experience with a math teacher as her mentor when she was a new teacher is exactly what is attempted to be replicated in this study for the participating teachers at this rural school.

The interviews helped me to conclude that the majority of the participants had negative experiences with mathematics and teaching mathematics. The teachers who participated in the interviews spoke of being ill-prepared to teach their math content. While the teachers answered the interview questions, they became frustrated and showed signs of anxiety; they became anxious as they talked about their mathematics experiences. However, the participants knew the importance of elementary math and wanted to increase their repertoire of methods to teach the math content, as well as practice the content to become more familiar and confident with the math content they are required to teach.

Final Meeting

Upon the completion of the professional development mentoring and coaching program, more positive perceptions of mathematics and their capacity to teach mathematics had developed for most of the participants. A fifth grade teacher stated that she used to look at math class time as something she had to do, so she pushed through it. However, after some extra support

provided through the professional development program, she has challenged herself to ensure every student gains a basic understanding of the math concept she is teaching. She stated that the professional development program helped her to build her confidence in teaching mathematics and overall changed her perception of teaching mathematics. Previously, this teacher said she was not sure she had the ability to teach the required math content to every child, but she has since changed her mind. This fifth grade teacher changed her perception of the difficulty in teaching elementary mathematics. The Conference Board of the Mathematical Sciences (2001) report designed to be a resource for the education of mathematics teachers, stated the importance of teachers needing to have classroom experience in which they become reasoners, conjecturers, and problem-solvers. Another participating teacher expressed growth in her mathematics' perceptions and teaching mathematics. This teacher felt she had previously struggled to get through math lessons, and thus her students struggled. This teacher now feels she has more tools and methods to more efficiently teach her students. The extra practice, mock lessons in the group trainings, and suggestions for grade level content helped her create a more efficient math classroom experience for her students. The coaching and mentoring program challenged teachers' opinions and perceptions of the needed math content expertise of elementary teachers.

Research Question 2: How Do the Participating Elementary Teachers Describe Their Level of Mathematics Anxiety?

It was more difficult than I anticipated to gauge the level of mathematics anxiety of the participating elementary teachers. As the program went on, I began to realize that some individuals may have been afraid to fully admit that math makes them anxious, even to themselves. Still there were indicators along the way that pointed to participants' levels of anxiety regarding both math content and math teaching. Before I sat down to interpret the data from the Initial Open-Ended Survey, I expected to see that a few teachers did not feel confident

with completing a math problem. I did not expect that number to be as high as 40%. Forty percent of the 20 participants reported they did not feel confident when completing a math problem. The coaching and mentoring program aimed to address that 40% by providing math content trainings, individual coaching and co-teaching, and open discussions in order to build the participating teachers' confidence in mathematics. It was also concerning to see that 28% of participating teachers, that is five out of the 18, reported they felt nervous, stressed, or overwhelmed when completing a math problem. Unfortunately, many elementary teachers have higher math anxiety than individuals in other fields (Battista, 1986; Bryant, 2009; Hembree, 1990). These feelings need to be addressed and significantly ameliorated if teachers are to be successful.

In the first group discussion I had with the participating teachers, I asked them if they believed elementary educators experienced math anxiety. Most nodded their heads yes. The challenge I found with addressing math anxiety was getting teachers to admit the depth to which they experience it. A few participating teachers did admit they have experienced math anxiety; however, more of the participants felt comfortable admitting certain math concepts trigger their math anxiety. One math concept that seemed to reoccur as a trigger of math anxiety for the participants was fractions. One second grade teacher even concluded her first feeling of math anxiety happened in her own fourth grade class, years ago, when her teacher tried to teach the class how to add fractions. Teachers stated that different teaching situations initiate their math anxiety as well. Third Grade Teacher B said, "I'll be honest. I get nervous about math stations because I feel that I waste that time." Math anxiety is prevalent in these participating elementary educators.

Group Training Sessions and Discussions

A hope of this project was that it might engage participants in thinking deeply about the fundamental underlying causes of their math anxiety and how best to overcome them. Math anxiety had certainly affected the participating teachers' learning and teaching; one participating teacher stated she had math anxiety her entire first year of teaching. Speaking of how her math anxiety negatively affected her teaching, Fifth Grade Teacher A said, "I was nervous I was going to mess up, and then I ended up confusing my students even more." Researchers have concluded that the teachers' math anxiety hinders their confidence, growth as a teacher, and their overall teaching mathematics efficacy (Brown, Westenskow, & Moyer-Packenham, 2011; Finlayson, 2014; VanderSandt & O'Brien, 2017). This study suggests teachers' math anxiety hinders their confidence as well. The participants became closed off and withdrew from the group activities when their math anxiety became triggered during a training on fractions. While participating in a group training session on how to find equivalent fractions, Fourth Grade Teacher A even said, "No wonder my students hate and are afraid of fractions, this lesson is making me nervous." For many participating teachers, math anxiety hindered their growth on the concept of fractions. After several coach-led examples followed by participants practicing the problems, the teachers were able to work through some of their anxiety with fractions in order to learn a new method to utilize in their classroom. However, it is reasonable to conclude that the participants still experience math anxiety across a range of mathematics topics and need support in the form of trainings and practice if they are to overcome their own math anxiety enough to increase their overall mathematics teaching efficacy. Previous studies concluded that a weak mathematical background is a factor that contributes to math anxiety (Brown et al., 2011; & VanderSandt & O'Brien, 2017). Participating teachers would benefit from opportunities to continue to develop their mathematical content knowledge across a wide range of topics.

Co-Teaching

Co-teaching with the volunteer participant also revealed math anxiety. In Chapter 4, I described the fifth grade teacher who became anxious when she had not taught unit conversions through ratios and became even more anxious when I taught her how to solve unit conversion problems using ratios. Using ratios is an easy way to solve unit conversions, but the teacher was initially too anxious to teach it that way. After we walked through examples, and with plenty of practice, her anxiety faded and she felt confident in learning a new method to help her students understand how to solve unit conversions. There is little research available on the effectiveness of co-teaching (Pace & Austin, 2003). However, Ford and Strawhecker (2011) did find that an effective co-teaching model for elementary mathematics teachers is beneficial when pairing an elementary educator and a math specialist.

Interviews

Not every participating elementary teacher revealed they felt math anxiety. One of the interviewees, Third Grade Teacher A, stated she had a math teacher as a mentor when she first began teaching. Therefore, due to experience, support, and adequate preparation she did not and does not become anxious about teaching math. However, that was not found to be the norm amongst the participants. Although the other three interviewees reported they do not experience math anxiety regularly, they do have math concepts that trigger math anxiety, such as fractions, conversions, math stations, and trying to teach the same content in multiple ways. Three of the four interviewees named fractions as the primary math concept that triggers their math anxiety. All of them felt a teacher's math anxiety negatively affects their students. Kindergarten Teacher A reflected how he had overcome his anxiety of fractions through practice and group trainings and discussions:

I know I felt insecure about my ability to teach fractions at a very low level, and I allowed that insecurity to hinder my growth as a teacher. However, the group trainings and discussions helped me to practice the content and to realize I'm not alone in my insecurities.

Final Meeting

The participants opened up more about math anxiety in the final meeting discussion. We concluded that while most every participant has felt math anxiety either while learning math or teaching math, it definitely is more extensive and prevalent when the individual is not prepared to teach their math content. The group also concluded this professional development coaching and mentoring program lowered any math anxiety they felt because they were forced to address the concept that triggered their anxiety head on and practice the content until they felt comfortable with teaching it to their students. Math anxiety is not an incurable disease. Math anxiety can be addressed and remedied with the proper support and resources. Providing teachers with resources to develop and practice their math content knowledge, while also providing continual support from instructional math coaches can help to ameliorate teachers' math anxiety.

Research Question 3: To What Extent Can a Tailored and Differentiated Mentoring and Coaching Program Affect Participating Teachers' mathematics Teaching Efficacy?

A tailored and differentiated mentoring program, like the one used in this study, can increase participating elementary teachers' mathematics teaching efficacy by decreasing their overall math anxiety and increasing their repertoire of efficient methods to teach math content to their students. The mentoring and coaching program lowered math anxiety for participating teachers and increased their repertoire of efficient math methods through group training sessions that were conducted to determine what the participating teachers felt they needed to know in

order to accomplish the goal of increasing their mathematics teaching efficacy. The mentoring and coaching program was also able to increase the participants' mathematics teaching efficacy by utilizing observations to locate any additional weaknesses they may have had, training sessions on math content and multiple methods to teach the math content, and providing a certified math teacher at the disposal of the participants for extra support when needed.

Group Training Sessions and Discussions

Upon the completion of every training session, we had a group discussion. In every group discussion the participants would speak of their growth as teachers. At the group trainings, the participants would gather knowledge, practice, and explore different methods to incorporate into their classroom lessons. The participants would feed off the confidence the added practice in the trainings would develop. They would then take that confidence and teach their math content with the new methods they learned or with the new math stations schedule we developed. The participating teachers would reflect on how their improved confidence in teaching their math content allowed for the lesson to run smoothly and for more of their students to grasp the math content they taught. The participants provided rich, descriptive responses to each open-ended question during the group discussions. From the group discussions I concluded that the participants felt an increase in their confidence in teaching mathematics, as well as their overall mathematics teaching efficacy.

The biggest increase in mathematics teaching efficacy came from the participants simply being more prepared to teach their math content as a result of the extra practice the group trainings provided. The participating teachers expressed concern about not knowing different ways to teach math content. Expanding on methodology to teach math content is exactly where a coaching and mentoring program can help. Most teachers know how to complete the content just not in a variety of methods. Reviewing the methods yearly can help keep teachers refreshed

and up-to-date on new teaching methods, increasing their overall mathematics teaching efficacy. Although it is not possible to change how teachers were prepared to become teachers after they are hired, it is possible to offer professional development to fill in the gaps they may have in content and add to their repertoire of how to teach the content. If this kind of targeted support and training is provided to teachers whose content knowledge is not strong, it can increase their confidence in subject matter and teaching, decrease their anxiety about teaching, and thus increase their overall mathematics teaching efficacy.

Observations

The observations that occurred throughout the coaching and mentoring program helped the teachers by providing feedback from their lessons and allowing them the opportunity to reflect on what they taught and how a mathematics teacher may have approached some things differently. At the initial observations with the participating teachers, the teachers showed signs of anxiety. They seemed anxious to have someone in their room observing their lessons. However, over time, and with communication between myself and the participants, we began to develop a relationship that allowed the teachers to feel comfortable with asking questions and reaching out for suggestions on how they could have made their math lesson smoother or more effective. Toward the end of the professional development mentoring and coaching program, the participating teachers began to feel comfortable enough to reach out to me and tell me different methods they would like for me to teach at the next training session. The participating teachers expressed how the support they received from a mathematics teacher, during and after the observations, helped motivate them to work harder and helped them build confidence in regards to their mathematics teaching. Gresham (2009) found similar results in her study that showed a gain of confidence and increased motivation in teachers when provided support in the means of observations and debriefs regarding those observations.

Interviews

The teachers that volunteered to be interviewed at the end of the professional development program aided in the research on the effectiveness and helpfulness of the professional development coaching and mentoring program. The participants gave a better perspective of the participating teachers' perceptions of mathematics, teaching mathematics, their own perception of their mathematics content knowledge, and their own math anxiety. The interviews also helped determine what extent a tailored and differentiated mentoring and coaching program can affect participating elementary educators' overall mathematics teaching efficacy. Educators need consistency to build a relationship with their academic instructional coach in order to help them feel comfortable enough to ask for help. A content specific school-based coaching and mentoring program could provide consistency and relationships for teachers.

Educators need coaches with extensive experience in both grade level and subject content. Educators need a coach who can take math content and math methods, and then teach them how to apply them in their classrooms. Bruce and Ross's (2008) study on academic coaches found evidence to support that academic coaches can increase the instructional self-efficacy of the teachers they work with. Kindergarten Teacher A commented on the helpfulness of this specific topic, "I really enjoyed having a certified math teacher take strategies such as 'math stations' and apply them to every grade level while teaching me how to implement them in my grade, kindergarten." There is a need for a program to reduce teacher math anxiety in order to increase their efficacy in teaching, and to provide support in lacking areas of our elementary educators.

This program can be created and implemented at every school by adding certified math teachers and academic coaches with a well-designed coaching and mentoring program that involves observations, individual coaching, group coaching, group trainings, and co-teaching

sessions. Hartman (2013) utilized four methods in her math coaching program: (a) indirect correspondence technique; (b) co-planning sessions with teachers; (c) co-teaching with receptive teachers; and (d) providing professional development by incorporating the district approved problem solving strategy into lesson planning. Hartman found these coaching methods to be successful in increasing teacher self-efficacy. The coaching and mentoring program implemented in this study utilized very similar methods of coaching in order to increase overall mathematics teaching efficacy: (a) observations of lessons; (b) co-teaching with receptive teachers; (c) group discussions; (d) individual suggestions; and (e) providing professional development in the form of group trainings on teacher selected topics.

Summary

The tailored and differentiated mentoring and coaching program designed and put to work in this school was successful, to a degree, in decreasing participating elementary teachers' math anxiety, increasing their confidence levels, and increasing their overall sense of mathematics teaching efficacy. However, the participating teachers still felt they were unprepared to teach mathematics to upper elementary grades based upon the content knowledge they acquired during their teacher education studies in college. Participating teachers did not have the content mastery they wanted or felt they should have. This mentoring and coaching program helped to address most of the participating teachers' concerns regarding their past negative experiences, increased their confidence in teaching mathematics, and reduced math anxiety they may have felt. This program was not long enough to fully address all the needs and fill in the gaps of missing math content for the participating math teachers, but it seems possible to design targeted and iterative professional development programs that would allow teachers to cultivate both the competence and the confidence they need to teach math well.

Implications for Actions

The findings of this study indicate that the participating elementary teachers did not feel prepared to teach the math content they are required to teach to third, fourth, and fifth grade students. The findings also imply that the participating elementary teachers experience math anxiety themselves while trying to teach their students and while practicing the more difficult concepts. Although this study was not designed to produce generalizable results, it is reasonable to suspect that teachers elsewhere who have had similar training and experiences might also experience similar deficiencies and anxieties. One possible implication for action might be to place elementary teachers across all experience levels into a coaching and mentoring program that could fill in gaps in their math content, which could also reduce their overall math anxiety. Teachers need to be taught a full repertoire of methods to teach all math content so they can best reach all of their students. A coaching and mentoring program like the one highlighted here could also provide teachers with extra support while planning new lessons, remediation for students, and increasing their confidence levels for teaching.

The findings of this study could be used to design and implement more targeted and particular coaching based professional development in mathematics for elementary teachers. The providers of professional development in West Virginia include, but are not limited to the West Virginia Department of Education, the county school districts, and higher education institutions. These professional development providers may gain useful insight into the design and implementation of professional development for elementary mathematics teachers which could help to increase their mathematics teaching efficacy. This study may also have significant value to elementary teachers, mentors and coaches, and administrators. Elementary teachers, mentors and coaches, and administrators could analyze the findings of this study and try to replicate the study in their own school in hopes of generalizing the findings of increasing

teachers' overall mathematics teaching efficacy. The findings of this study can be considered when designing a professional development program for elementary teachers to increase their mathematics teaching efficacy.

Recommendations for Future Research

This study on elementary teachers' perception on mathematics anxiety, teaching, and coaching brought forth multiple items recommended for future research. Student math anxiety needs to be researched in order to have a better idea of how much teacher math anxiety truly impacts student math anxiety and student math achievement. Wu et al. (2012) found math anxiety present in second grade children, but not many studies have investigated where elementary children's math anxiety stems from. If the experience of these participants is any indication, it could be connected to the anxiety their teachers experience in trying to teach content they have not yet mastered.

Another issue recommended for future research has to do with the number and depth of math content courses required in teacher preparation programs. Every participating elementary teacher in this study was required to take only one math content class to become an elementary teacher, and each one reported they did not learn enough about math in college to be prepared to teach third, fourth, and fifth grade math content. The feeling of being unprepared provokes its own anxiety. Research needs to be conducted on the math content requirements for elementary teachers and how prepared those teachers feel once they get into their own classrooms.

This study suggests a tailored and differentiated mentoring and coaching program, like the one implemented in this study, can increase teacher efficacy by filling in any gaps elementary educators may have in mathematics, increasing their teaching confidence, and reducing any mathematics anxiety they may feel. Therefore, more research needs to be completed on coaching and mentoring programs in the elementary setting and how such programs could affect

participating elementary teachers. Conducting studies like this in other areas of the state, in other states, or even at a national level would be beneficial for the purposes of comparison and generalizing findings. This study could also be repeated at a different school with a bigger focus on identifying the participating teachers' mathematics anxiety quantitatively. The participating teachers could participate in a mathematics anxiety survey specifically developed for in-service teachers. This information could be very useful in gathering pre and post professional development anxiety scores.

This study only lasted one school semester. It may be more beneficial to spread the study out over the course of an entire year in order to include the summer months into the professional development program. One more suggestion for future research would be to analyze the impact of having a certified mathematics teacher in the participating school daily. In order for academic coaching to be successful, the coach must change the culture in the school; they must build and sustain collaborative positive relationships with their teachers (Hartman, 2013).

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APPENDIX A: OFFICE OF RESEARCH INTEGRITY LETTER

w w w . m a r s h a l l . e d u

Office of Research Integrity
Institutional Review Board
One John Marshall Drive
Huntington, WV 25755

FWA 00002704

IRB1
#00002205
IRB2
#00003206

May 10, 2018

Elizabeth Campbell, Ph.D.
Doctoral Programs in Education, MUGC

RE: IRBNet ID# 1232024-1
At: Marshall University Institutional Review Board #2 (Social/Behavioral)

Dear Dr. Campbell:

Protocol Title:	[1232024-1] Math Mentors: Elementary Teachers' Perceptions of Mathematics Anxiety, Teaching, and Coaching
Expiration Date:	May 10, 2019
Site Location:	MUGC
Submission Type:	New Project APPROVED
Review Type:	Expedited Review

In accordance with 45CFR46.110(a)(5)(6)&(7), the above study and informed consent were granted
Expedited approval today by the Marshall University Institutional Review Board #2 (Social/Behavioral) Chair for the period of 12 months. The approval will expire May 10, 2019. A continuing review request for this study must be submitted no later than 30 days prior to the expiration date.

This study is for student Brittany Porter.

If you have any questions, please contact the Marshall University Institutional Review Board #2 (Social/ Behavioral) Coordinator Bruce Day, ThD, CIP at 304-696-4303 or day50@marshall.edu. Please include your study title and reference number in all correspondence with this office.

APPENDIX B: IRB CONSENT

Informed Consent to Participate in a Research Study

Math Mentors: Elementary Teachers' Perceptions of Mathematics Anxiety, Teaching, and Coaching

Elizabeth Campbell, Ph.D., Principal Investigator
Brittany Porter, Ed.S., Co-Investigator

Introduction

You are invited to be in a research study. Research studies are designed to gain scientific knowledge that may help other people in the future. You may or may not receive any benefit from being part of the study. Your participation is voluntary and you may withdraw at any time. Please take your time to make your decision, and ask the Co-Investigator Brittany Porter to explain any words or information that you do not understand.

Why Is This Study Being Done?

The purpose of this study is to explore the current confidence levels of participating elementary teachers with regards to teaching mathematics and their current levels of math anxiety, to provide participants with resources to increase their confidence in their ability to be effective elementary math teachers, and to decrease their math anxiety. The interview questions will help me to determine how the teachers feel about math, teaching math, their confidence levels in teaching mathematics, their math anxiety and their perceptions about mathematics. This study will explore to what extent a tailored and differentiated mentoring and coaching program affects participating elementary teachers' efficacy.

How Many People Will Take Part In The Study?

For this study, a group of seven to eight teachers who have already participated in the two semester long mentor and coaching professional development program at _____ Elementary, in _____, WV, will participate.

What Is Involved In This Research Study?

Fifteen elementary educators who work at _____ Elementary for the _____ County Board of Education in WV, have been participating in a two semester long voluntary mentoring and coaching professional development program. I will send out an e-mail to participants describing the interview portion of the study and asking for volunteers. Once I have received seven to eight volunteers for the interview portion of the study, I will e-mail the interview questions to the interviewees in advance and set up appropriate times to complete the interview. After I have completed the interviews I will analyze them for commonalities and themes. I will determine whether or not the teachers used keywords, phrases, or concepts. Once I have determined the emerged themes, I will conduct follow-up sessions through a group interview where we can further discuss the teachers' responses. Participants who elect not to participate in a group interview may elect to have an additional individual interview.

I will also take detailed field notes on my observations, co-teaching sessions, coaching, and mentoring sessions.

How Long Will You Be In The Study?

You will be in the study from May 1 to June 30, 2018.

You can decide to stop participating at any time. If you decide to stop participating in the study, we encourage you to talk to the Co-Investigator Brittany Porter as soon as possible.

The study investigator may stop you from taking part in this study at any time if he/she believes it is in your best interest; if you do not follow the study rules; or if the study is stopped.

What Are The Risks Of The Study?

There are no known risks to those who take part in this study.

Are There Benefits To Taking Part In The Study?

If you agree to take part in this study, there may or may not be direct benefit to you. We hope the information learned from this study will benefit other people in the future. The findings will contribute to the body of information on mentoring elementary teachers to increase their perceptions of math anxiety, teaching, and coaching.

What About Confidentiality?

We will do our best to make sure that your personal information is kept confidential. However, we cannot guarantee absolute confidentiality and anonymity. The researcher will not share interview content with other project participants without the individual's consent. One group audio-recorded interview will take place for which confidentiality cannot be guaranteed; the choice to participate in that interview will be yours alone. The individual interviews will be audio-recorded as well. Although the purpose of this study is not to provide a venue for expressions of discontent with particular jobs, professional development, or teacher preparation programs, the researcher recognizes that such expressions could occur. In these cases, if the researcher wishes to include such materials she will ask the participant for explicit permission for those materials and use them in such a way that the participant will not be identifiable in the research. All forms will be collected and maintained in locked cabinets during the study; all forms will be destroyed by the co-investigator after the final report is written. The audio recorded interviews, both group and individual, will be kept until the completion of the project and then destroyed. Federal law says we must keep your study records private. Nevertheless, under unforeseen and rare circumstances, we may be required by law to allow certain agencies to view your records. Those agencies would include the Marshall University IRB, Office of Research Integrity (ORI) and the federal Office of Human Research Protection (OHRP). This is to make sure that we are protecting your rights and your safety. If we publish the information or interviews from this study, you will not be identified by name or in any other way.

What Are The Costs Of Taking Part In This Study?

There are no costs to you for taking part in this study. All the study costs, including any study tests, supplies and procedures related directly to the study, will be paid for by the study.

Subject's Initials _____

Will You Be Paid For Participating?

You will not be paid for participating in this study.

What Are Your Rights As A Research Study Participant?

Taking part in this study is voluntary. You may choose not to take part or you may leave the study at any time. Refusing to participate or leaving the study will not result in any penalty or loss of benefits to which you are entitled. If you decide to stop participating in the study we encourage you to talk to the investigators or study staff first.

Whom Do You Call If You Have Questions Or Problems?

For questions about the study or in the event of a research-related injury, contact the study investigator, Dr. Elizabeth Campbell at campbelle@marshall.edu. You should also contact the investigator if you have a concern or complaint about the research.

For questions about your rights as a research participant, contact the Marshall University IRB#2 Chairman Dr. Christopher LeGrow or ORI at (304) 696-4303. You may also call this number if:

- You have concerns or complaints about the research.
- The research staff cannot be reached.
- You want to talk to someone other than the research staff.

You will be given a signed and dated copy of this consent form.

SIGNATURES

You agree to take part in this study and confirm that you are 18 years of age or older. You have had a chance to ask questions about being in this study and have had those questions answered. By signing this consent form you are not giving up any legal rights to which you are entitled.

_____

Participant Name (Printed)

_____

Participant Signature Date

_____

Person Obtaining Consent (Printed)

_____

Person Obtaining Consent Signature

APPENDIX C: INITIAL OPEN-ENDED SURVEY

Initial Open-Ended Survey

1. How do you feel when doing a math problem?

2. What do you like about math? What do you dislike?

3. What do you need to know about math to teach young children?

4. Do you like mathematics? Why or why not?

5. Why do you think math is important to learn in the grade you teach? (Be sure to list the grade you teach.)

6. Tell me how you think about math when planning activities for children.

7. Tell me how you would teach math to a first grade child.

8. What is important to remember when teaching math to young children?

9. Is it important for your grade to learn math skills? Why?

APPENDIX D: INTERVIEW QUESTIONS

Individual Interview Questions

1. What is your teaching certification? What about your educational background?
2. How long have you been teaching? What all subjects have you taught?
3. What all math courses have you taken in college, and at what college(s)?
4. What is your favorite subject and grade to teach and why?
5. Do you enjoy doing math? Why or why not?
6. Do you enjoy teaching math? Why or why not?
7. Do you feel like the math content you received in college while obtaining your undergraduate degree was enough to develop the mathematical sense and knowledge to teach elementary mathematics? Why or why not?
8. Can we describe your experience with mathematics teaching and learning?
9. Do you find students are afraid or anxious about mathematics? What indicators are there?
    a. If so, does that anxiety hinder their learning?
10. How do you feel about mentoring and coaching?
    a. Do you feel it helps, why or why not?
11. Do you experience anxiety about math or teaching mathematics?
    a. If so can you explain what about math or teaching math provokes your anxiety?
    b. Do you remember when and how the first feelings of math anxiety came about?
    c. Do you have any suggestions on what could help alleviate your math anxiety?
12. Do you feel that a teacher's math anxiety affects their students?
13. Are you confident in your mathematics abilities? Why or why not?
14. Are you confident in your mathematics teaching? Why or why not?
15. What are some of the most common challenges you have seen with teaching mathematics in your classroom?
    a. What do you think causes those challenges?
    b. How do you address those challenges so you can move on in your classroom?

APPENDIX E: LETTER TO PARTICIPANTS

Dear Participant,

You are invited to participate in a doctoral research project entitled *Elementary Teachers' Perceptions of Teaching Mathematics, Mathematics Anxiety, and Teaching Mathematics Efficacy,* designed to examine your perceptions about teaching mathematics, mathematics anxiety, and teaching mathematics anxiety throughout a coaching and mentoring professional development program. This research study is part of the dissertation requirement for Brittany Porter. The study is being conducted by Dr. Elizabeth Campbell and Brittany Porter from Marshall University and has been approved by the Marshall University Institutional Review Board (IRB). Your opinions, participation, and perceptions are very important to the success of this study.

Participants will complete an Initial Open-Ended Response Survey to guide the coaching and mentoring program. Your responses on the Initial Open-Ended Response Survey will be analyzed to determine which topics, methods, and concepts you want and need to focus on throughout the coaching and mentoring program. The coaching and mentoring program will include bi-weekly group trainings and discussions on these topics and concepts, one-on-one coaching, co-teaching, observations, and interviews. The purpose of the coaching and mentoring program is to help you overcome any math anxiety feelings you may possess and to increase your comfort levels with your math content knowledge.

Your confidentiality and anonymity will be protected throughout the research. Participants will be named and referenced by the grade level they teach. Your school's identity will also be protected. There are no known risks involved with this study. There will be no penalty or loss of benefits should you choose to not participate or to withdraw. Participation is completely voluntary. If you have questions or concerns about this study, you may contact me at 304-654-6468 or Dr. Elizabeth Campbell at campbell@marshall.edu.

If you have questions concerning your rights as a research participant, you may contact the Marshall University Office of Research Integrity at 304-696-4303.

Thank you in advance for your participation in this coaching and mentoring program and research study.

Sincerely,

Brittany Porter

APPENDIX F: STUDY PARTICIPANTS

Fifth Grade Teacher A

Fifth Grade Teacher B

First Grade Teacher A

Fourth Grade Teacher A

Fourth Grade Teacher A

Fourth Grade Teacher B

Kindergarten Teacher A

Kindergarten Teacher B

Second Grade Teacher A

Third Grade Teacher A

Third Grade Teacher B

APPENDIX G: VITA

Curriculum Vita Spring 2019

Brittany E. Porter

Lincoln County High School
81 Panther Way
Hamlin, WV 25523
Phone: 304-824-6000

5136A Lower Heath Creek Rd.
Barboursville, WV 25504
Phone: 304-654-6468
Email: beporter@k12.wv.us

Education

Educational Specialist (EdS), 2017
Marshall University

Master of Arts (MA), 2013
Marshall University
Major: Leadership Studies

Bachelor of Science (BS), 2007
West Virginia State University
Major: Secondary Education Mathematics (Math 5-12)

Professional Work Experience

Math Teacher in Lincoln County, WV (2008-Present)

Dual Credit Teacher (2018-Present)
Marshall University
Lincoln County High School
Hamlin, WV

Adjunct Education Professor (2017-Present)
Marshall University
Huntington, WV

Adjunct Math Professor (2011-2012)
Southern West Virginia Community and Technical College
Hamlin, WV 25523

Math Teacher in Flour Bluff Independent Schools, TX (2010-2011)

Certification/License

WV Supervisor of Instruction, k-12	2014
WV Administrative Certificate, k-12	2014
WV Teacher's License, Math 5-12	2007
AP Calculus AB, College Board Certified Teacher	2016
AP Calculus BC, College Board Certified Teacher	2014

Related Experience

Co-Curator of the West Virginia Activist Archive Project Exhibit — January 2016-May 2016
Marshall University, Huntington, WV
Conducted an extensive oral history on a WV activist in rural education for the West Virginia Activist Archive Project Exhibit — January 2016-May 2016
Marshall University, Huntington, WV

Produced two activist posters for the West Virginia Activist Archive Project — January 2016-May 2016
Marshall University, Huntington, WV
Generated a portfolio on Michelle Gaines, a WV activist; including oral history, short biography, interviews, and poster.

Lincoln County High School Varsity Cheerleading Coach — 2009-Present
Hamlin, WV

RESA 2 Math Tutor — 2013-2014
RESA 2, Huntington, WV

Awards

Governor's Honors Academy — 2013
Teacher of the Year, picked by attending student

Publications

AP Calculus AB Syllabus for AP Central College Board	2014
AP Calculus BC Syllabus for AP Central College Board	2014

Presentations

Prospectus of "Math Mentors: Elementary Teachers' Perceptions of Math Anxiety, Teaching, and Coaching" for the Doctoral Program at Marshall University — 2018
Portfolio Defense for the Doctoral Program at Marshall University — 2017

Math III TR, Math III LA, & Math III Stem — 2014
WV Department of Education and RESA 2 partnership

Workshop Participation

Positive Behavior and Intervention Support (PBIS) 2014-2016
Logan, WV

LINKS Training for Academic Advising 2015
Bridgeport, WV

AP Calculus AB Training 2008-2016

AP Calculus BC Training 2014

Freshman Transition Training 2013
Los Angeles, California

National Board Certification Preparation 2013
West Virginia Center of Professional Development, Charleston, WV

Educational leadership Academy 2013
West Virginia Center of Professional Development, Charleston, WV

Talented and Gifted Students in the Classroom 2010
Flour Bluff Independent School District, Corpus Christi, TX

References

Tab Mathis
Principal, Harts Intermediate School
1 Harts Creek
Harts, WV 25524
Telephone: 304-855-4881 email: tjmathis@k12.wv.us

Ronald Childress, Ed.D.
100 Angus E. Peyton Drive
South Charleston, WV 25303
Telephone: 304-746-1904 email: rchildress@marshall.edu

Sue McComas
Assistant Principal, Lincoln County High School
81 Lincoln Panther Way
Hamlin, WV 25523
Telephone: 304-824-6000 ext. 1062 email: smccomas@k12.wv.us

Derek Christian
Assistant Principal, Lincoln County High school
81 Lincoln Panther Way
Hamlin, WV 25523
Telephone: 304-824-6000 ext. 2127 email: dachrist@k12.wv.us

Jennifer Ross
Principal, Salt Rock Elementary
5570 Madison Creek Road
Salt Rock, WV 25559
Telephone: 304-736-3037 email: jaross@k12.wv.us

Jennifer Jackson
Assistant Professor, Marshall University
College of Education and Professional Development
One John Marshall Drive
Huntington, WV 25755
Telephone: 304-542-4430 email: Jennifer.jackson@marshall.edu